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The "Nickel-in-the-Slot" Phonograph.

The Automatic Phonograph Exhibition Company was organized in February last, the object being to manufacture and introduce machines for automatically exhibiting the phonograph through the medium of a nickel or coin dropped into a slot. The officers and directors of the company are as follows: Felix Gottschalk, of the Metropolitan Phonograph company, is the president; Chas. P. Bruch, treasurer; T. T. Eckert, Jr., secretary; Chas. A. Cheever, Samuel Insull, Chas. P. Bruch and Felix Gottschalk, directors. The offices of the company are at 13 Park Row.

The company owns and controls a large number of patents and inventions which have been acquired from various inventors, among whom are several well-known to the readers of the ELECTRICAL REVIEW, viz., Lieut. F. W. Toppan, U. S. N.; E. T. Gilliland, Louis Glass, of San Francisco; Albert K. Keller, J. F. Gilliland, superintendent of the Gilliland Electric Works, and Mr. Lombard, of the North American Phonograph Company.

The machine shown in the illustration is the one that is at present being put out by the company. It was invented by Gilliland and Keller, and was manufactured by the Gilliland Electric Works, at Adrian, Mich.

The company is putting out a large number of these machines throughout the entire country. Several of them have been placed at Coney Island, and have attracted a great deal of attention. They are constantly surrounded by crowds which have patronized them very liberally, single machines having earned as much as $18 in one day. The company expects to place throughout the United States about 10,000 of these machines as rapidly as they can be manufactured. The company works under the authority of the North American Phonograph Company, and has contracts with the various sub-companies who own and control the phonograph for nearly all the territory in the United States.

The earning capacity of the nickel in-the-slot phonograph more than quadruples that of the weighing scale on its introduction, and has the additional attractive feature that the programmes can be changed from day to day and produce an endless variety of entertainment.

The working of this new machine is exceedingly simple, and the work done by the reproducing instrument is really wonderful, the sounds being so clear and distinct that it is only necessary to close the eyes to make one imagine himself in the actual presence of the musician. When the nickel is dropped in it releases a catch that holds a rod, the end of which is in plain view at the right of the upper portion of the case which carries the machine. By pressing this handle in as far as it will go the phonograph cylinder is set in motion, and then, if the ear pieces are placed in the ear, the music is plainly heard.

The length of time the sounds are continued is regulated by an attachment that requires setting, and which is not automatic until set, when it is sure, however, to stop the music at the exact time required. When the nickel does its work it drops into a receiver in plain view behind a glass, where it remains until the next nickel is dropped in, when it is pushed down to the safe, which stands in the middle compartment of the case. In this compartment will also be kept a number of spare cylinders, so that a constant change can be made in the tunes played, whenever the proprietors of the instrument wish to do so.

In the lower compartment is kept the battery which works the phonograph. The appearance of the case, which stands about four feet high, is very neat, and would attract but little attention were it not for the glass top, through which the little machine and nickel-worked attachment are plainly visible. On top of the case the words "Automatic Phonograph" explain what it is.

The cylinders used in these phonographs are loaded with everything, from a dialect story to a full brass band, so that every one may be suited, as long as his nickels hold out. At 257 Fifth avenue, this city, are the offices of the local phonograph company.

In one of the upper floors of this building is a room devoted to the preparation of cylinders, both for private use and for the automatic phonographs. The lighter music,

LISTENING TO THE AUTOMATIC PHONOGRAPH.

speeches and stories, are here recorded on the cylinders, while a building in Jersey City is used when an orchestra or a full brass band performs.

The demand for these cylinders by private parties, for use as a home amusement, is very great. A number of men are kept busy all the time preparing cylinders for sale. They are worth from a dollar to a dollar and a half apiece.

A miniature theatrical bureau is run in connection with this business, banjo artists, singers, variety actors and bands, are all especially engaged. When a representative of the REVIEW called at the Fifth avenue office, the piccolo player from Cappa's Seventh Regiment Band was playing "Home, Sweet Home," into three big brass funnels connected with three phonographs.

To say the least, the automatic phonograph is a decided improvement on the average nickel-in-the-slot machine, and it ought to make money for the men behind it.

The Electric Motor for War Trains.

It is proposed to use the electric motor extensively in military operations in England. One of the latest ideas in carrying on active warfare is to build a railway at the scene of hostilities for the transportation of ordnance. It is highly desirable that the trains used for this purpose, which are armor-plated and armed with Gatling guns, should be as rapid and inconspicuous as possible. The use of steam for them is open to grave objections, one of which is that coal smoke is an excellent guide by which an enemy could trace the progress of the engine, and lay his guns for it accordingly. The electric motor is quick and silent, and has no smoke to betray its whereabouts, and it is remarked as the coming mode of propulsion for war trains.

In machine shops it is a frequent occurrence that particles of metal penetrate in the skin and eyes. Messrs. Frister & Rossman have, according to *Revue Industrielle*, constructed a magnet for the special purpose of extracting such particles. It is horseshoe shaped, polished and nickel-plated; the two branches are rounded off and end in a point only a few millimetres thick. Its attraction for iron extends for several millimetres.

We are informed that the electric battery has superseded the hose and cold water treatment for taming refractory prisoners in the Ohio Penitentiary. It is reported to be very efficacious.

The Electric Tree Cutter.

In the great forests of Galicia electricity is employed for felling trees. The tool used for comparatively soft woods is a form of auger which is moved to and fro, and revolved at the same time by a small electric motor. The tool and motor are mounted on a carriage which turns on a vertical axis secured by an arm to the trunk of the tree. The auger or blade describes an arc making a deep cut in the trunk, operating much in the same manner as a mortising machine. The tool is gradually advanced, after each half turn around the trunk, thus deepening the cut until it reaches about half the diameter of the tree; wedges are then inserted to prevent the rift from closing up, and the other side of the trunk is operated upon until the tree is nearly cut through. The job is then finished off with an axe or a hand saw. In this manner the work of felling trees is accomplished with great rapidity and a very small amount of labor. Truly, there are few fields of industry in which electricity, and especially, electric power, is not able to effect improvements and economies. Science now supplants the woodchopper, and a popular poem should read, if modernized, "Electricity, spare that tree."

Submarine Cable Work in France.

The Société Générale des Téléphones, of Paris, France, is about to engage in the business of submarine cable manufacture and laying. Large works, covering more than 5,000 square metres, have been erected at Calais, and the construction of submarine cables will be carried on there continually. A steamer 350 feet long is being built for the company, and will be provided with the most improved machinery for cable laying and repairing. The first cable made by the Société Générale has just been laid in the West Indies, between Demerara and Cayenne. A contract has recently been made with the French West India Telegraph Company, for the manufacture and submersion of 3,000 miles of cable, and, no doubt, more important orders will be obtained from the French government, several cables of the Mediterranean system being in bad condition and needing replacement by new ones. This is the first submarine cable enterprise of any importance established out of England.

FINANCIAL.

Closing quotations of electric stocks, from F. Z. Maguire, 18 Wall street, N. Y., Saturday, August 2. New York, Boston and Washington Stock Exchanges.

NEW YORK.

Western Union Telegraph Co.	83⅞.
Edison General Electric Co.	107.
" " " Deferred	96.
Consolidated Electric Light	60.
Edison Electric Illuminating Co.	70.
United States Electric Light	25.

BOSTON.

Thomson-Houston Electric Co.	53.
" " " Preferred	25.
" " " Series C	12.
" " " Series D	6⅛.
" " International	
" " Welding Co.	
" " European Welding Co.	91.
Ft. Wayne Electric Co	12⅜.
TELEPHONE:	
American Bell	227½.
Erie	54.
New England	53¾.
Mexican	.80
Tropical American	
MISCELLANEOUS:	
Edison Phonograph Doll	3⅛.

WASHINGTON.

Pennsylvania Telephone	25.
Chesapeake and Potomac	*76½.
American Graphophone	16½.
United States Electric Light (Washington)	164.
Eckington and Soldiers' Home Railway	69.

*Ex. Dividend.

Gelatinous Electrolytes for Storage Batteries.

BY DR. PAUL SCHOOP.

An electrolyte for battery purposes is expected to be of high conductivity and to be constant during the use of the cell. Both conditions are fulfilled with a solution, particularly if it is kept in constant motion. As a rule, the less fluid a solution is, the greater its resistance. But the fluid state of an electrolyte also presents disadvantages, at least, from a practical point of view. The solution is easily spilled, it evaporates, its density becomes unequal. The dry cell has lately come into use for testing purposes on account of its transportability, though the capacity of it is inferior to the fluid cell.

For secondary batteries a solid electrolyte has even more importance than for primary batteries. As is well-known, the storage of the current is effected by means of a spongy material, both on the positive and the negative plates; and it matters not whether this has been applied to the electrodes (or plates) mechanically or chemically. Practical experience shows that under ordinary circumstances the active material frequently drops out, and sometimes short circuits the plates.

If the cell is much shaken, as in the case of traction cells, the liability of detaching the active material becomes increased. Therefore, many efforts have been made to render the liquid solution more stiff; and sand, glass, wool, cellulose, asbestos fibre, woolen fibre and saw dust, have been propposed. None of these substances have been used on an extensive scale, for the obvious reason that their absorbing power is not large; moreover, being non-conductors, these substances introduce a large resistance. But there are some bodies, a very small quantity of which may convert fluids—water, for instance—into a solid mass. Glue, gelatine, agar-agar, starch dissolved in water (about three to five per cent. of the weight of the water) make it gelatinous. These substances have, of course, also been tried, but without success. Acids produce chemical reactions upon these bodies, and soon convert them into a fluid mass again; so also do some salts (chloride of zinc, for instance). No organic matter is likely to stand the action of the highly active oxygen developed by the electrolysis of water, even if it should stand the action of the sulphuric acid.

There is an inorganic substance, one of the most stable compounds known in chemistry, which has important gelatinizing qualities—silicous acid. The salts of this acid, silicate of sodium and in a less degree silicate of potassium, are in common use. To obtain the gelatinous form of silicous acid, a dilute solution of silicum of sodium, say of 1.100 specific gravity, is mixed with dilute sulphuric acid of 1.200 specific gravity. Hydrochloric acid, or nitric acid, or nearly any other acid, will answer the purpose; also, all salts of ammonia, mixed with the solution of silicate of sodium, precipitate gelatinous silicous acid.

Suppose a storage cell has to be filled with gelatinous electrolyte. Three volumes of sulphuric acid, specific gravity 1.250, are mixed with one volume of silicate of sodium, specific gravity 1.180. The mixture remains at first perfectly fluid, but becomes more and more stiff and thick, and is gelatinous after two hours. After 24 hours, the maximum stiffness is apparently reached. In charging the cell, an interesting phenomenon is observed. As more current is taken up, so more water appears on the surface of the gelatine, and at last, when the cell is fully charged, a thin layer of acidulated water is on the top. This water disappears completely during the discharging of the cell, and the discharged cell is as dry as it was before. This process is repeated at every charge and discharge. The gelatinous mass is very elastic, and makes a perfect contact with the electrodes. If the latter develop gas bubbles (at the end of the charge or during over-charging), these bubbles force their way between the plate and the gelatine, pressing the latter back for a moment, and come out on top of the cell. After the gas bubble has escaped, the gelatine at once touches the plate again and makes contact. This elasticity is one of the most satisfactory features of this gelatinized acid. The resistance of such an electrolyte is greater than that of the fluid dilute sulphuric acid, but the increase is not so important as to be a practical drawback. This will appear from the following tables, containing a charging and discharging of the same cell, filled at first with ordinary sulphuric acid (specific gravity 1.850), and afterwards filled with gelatinous acid, made in the manner described above. These numbers represent the average of half a dozen tests respectively.

CHARGING.

(Cell filled with dilute sulphuric acid of 1.185 specific gravity.)

E. M. F.	Amperes.	Hours.	Watt hours.
1.94			
2.08	35		
2.12	30	After ½ hour.	15.9
2.13	30	" ½ "	31.87
2.14	30	" 1 "	63.97
2.14	22	" 2 "	119.61
2.14	19	" 3 "	160.27
2.14	14	" 4 "	190.23
2.14	12	" 5 "	215.91
2.14	11	" 6 "	239.45
2.14	8.5	" 7 "	257.64
2.14	8.0	" 8 "	274.76
2.14	6.0	" 9 "	287.60
2.14	6.0	" 10 "	300.44

This charging was done with a constant E.M.F. between the poles of the cell; and it is preferable to the method of keeping the current constant, because a cell is sooner charged and without developing gas bubbles, which in the other way always begin to appear in the latter part of the charging period.

CHARGING.

(Cell Filled with Gelatinous Electrolyte.)

E. M. F.	Amperes.	Hours.	Watt hours.
1.84			
2.19	34		
2.18	33	After ¼ hour.	18.0
2.18	31	" ½ "	34.4
2.185	29	" 1 "	66.1
2.18	25	" 2 "	120.6
2.18	20	" 3 "	164.2
2.19	17	" 4 "	201.4
2.21	13	" 5 "	230.1
2.19	8	" 6 "	247.6
2.185	6	" 7 "	260.7
2.19	6	" 8 "	273.8
2.19	5½	" 9 "	285.8

DISCHARGING.

Ordinary dil. acid (1.185–1.210).			Gelatinous Electrolyte.		
Volts	Starting.	Watt hours	Volts	Starting.	Watt hours
1.98			1.895		
1.96	After 1 hour	19.6	1.89	After 1 hour	18.9
1.96	" 3 "	58.8	1.89	" 3 "	56.7
1.95	" 5 "	97.8	1.86	" 5 "	93.9
1.93	" 7 "	136.4	1.84	" 7 "	130.7
1.92	" 9 "	174.8	1.80	" 9 "	166.7
1.88	" 11 "	212.4	1.76	" 10 "	184.3
1.87	" 12 "	231.1			
1.83	" 13 "	249.4			

Current constant at 10 amperes.

The cell in question consisted of seven positive and eight negative plates, each about $\frac{7}{64}$ of an inch thick; the weight of the plates (with paste) was 27 lbs., the weight of the electrolyte (in both cases the same weight), 17 lbs., the whole cell weighing about 46 lbs.

From the figures given in the tables, it will be seen that the capacity of the cell with "gelatinous electrolyte" is only three-quarters of that of the same cell with dilute sulphuric acid, This seems at first a considerable drawback, but looking at the matter more closely it is not so alarming. The diffusion with gelatinized sulphuric acid goes on slower than in the other case; and this is the reason: If the plates are chosen thinner, say, if 14 positive and 15 negative plates, each only half as thick as before, about $\frac{1}{10}$ of an inch, and are put together as elements, the capacity of the cell with gelatinized acid is the same as has been found with the 15 thicker plates in ordinary acid. Practical experience has shown this, and also the reliability of such thin plates. But in fluid sulphuric acid, as it is known, such thin plates have a very limited life, on account of the support of the active material being insufficient. In this way, the resistance of the dry cell is also reduced to the usual figure, and it may be said that the distance between the positive and negative plates can be decreased as far as is necessary to overcome the higher resistance caused by the introduction of the gelatinizing substance into the electrolyte.

Another point in connection with the "gelatinized electrolyte" is worth mentioning. It is known that the greater the rate of discharge the less is the available capacity of a cell. For instance, if the same cell which gives 250 watt hours capacity (discharged with 10 amperes) is discharged with 100 amperes, it will be found to have only about half the capacity. That means that the acid already present within the active material is first used up, and after this only the acid which comes into the active material by diffusion or transportation of the irons. It can be stated that the accumulator with the greatest amount of acid mixed with the active material, delivers the heaviest discharges for the longest periods. The utmost porosity of the active material is, therefore,

IMPROVED TWO SPINDLE DRILL.

desirable; but it can only be realized in combination with a solid material of sufficient elasticity to keep the loose powder in its place.

It would seem from these explanations that there is a large field for the use of gelatinized acids in connection with storage batteries. The certainty of working which results from the use of a storage battery has perhaps been the most powerful reason for its introduction in the electric lighting business, and yet this certainty is only relative. Short circuiting, caused by the dropping out of the active material, has too often been a cause of trouble, not to speak of the breaking of a vessel. Gelatinized sulphuric acid avoids all this. After two years' practical experience no short circuiting has occurred, and even cells in broken vessels have more than once done service for a week and more.

Voting by Electricity.

The House committee on rules last week gave a hearing to John A. Enos, an inventor, who seeks to have an appropriation of $60,000 made to defray the cost of installing his patent electric voting machine in the House of Representatives. Mr. Enos explained the workings of his machine and brought to the attention of the committee some facts to demonstrate its probable utility and economy. He stated, for instance, that during this session there have been over 300 roll-calls, each consuming 30 minutes' time, or an aggregate of 30 working days; and he asserts by the use of his machine 25 days could have been saved. The committee took the matter under advisement.

After a stubborn fight between rival companies and the city authorities, the city council of Little Rock, Ark., has granted to the Capitol Street Railway Company the right to put in electric motors on their 15 miles of road. The electric lines will be constructed at once and will cost $300,000. H. G. Allis, G. R. Brown, W. M. Stannus, G. B. Rose, John M. Taylor and H. P. Bradford, represent the Capitol Company.

Sigourney Two Spindle Drill.

The Sigourney Tool Company, of Hartford, Conn., have recently put upon the market a two spindle drill, which ought to be a valuable acquisition to any electrical machine shop.

This machine, besides carrying two spindles, has a somewhat greater capacity than a single spindle drill, as it admits work of a diameter of 13½ inches on the table. The downward throw of the drill without re-adjustment of the table is 2¼ inches. The table has a vertical range of 30 inches, and shafts can be centered to the length of 38 inches. The table is counterbalanced by a weight inside the column, and can be turned to the right or left, as required. On the stud of the lever pinion is a clamp stop, which is instantly adjustable to determine the depth of the hole to be drilled to the limit of the traverse of the spindle.

On the side of the column is a planed line and on the table bracket is a corresponding mark, which, when coincident, insure the exact agreement of the center of hole in table and of the spindle. The spindles are fitted to No. 1 Morse drill taper, and have three changes of speed. The spindle and its appurtenances are counterbalanced by an open coiled spring concealed in a cylindrical case above the spindle pulley.

Diameter of tight and loose pulleys is five inches, the recommended speed being 450 revolutions. Shipping levers are placed on either side of the machine.

Calumet and Hecla.

The following monthly detailed product of the greatest copper mine in this country, if not in the world, cannot fail to be of interest. The statement is from official figures, covering the financial years of the company, and has never before been made public in this form.

It will be seen that the percentage of ingot copper in the mineral has gradually declined through the four years given. While this is, doubtless, due largely to the manner of treating the rock, it certainly shows that the mineral (the usual form in which the product is given to the public) now realizes only 1,338 pounds of ingot copper to the ton, against 1,581 pounds five years ago; or, to put it more clearly, the product for April, 1890, of 3,744 tons 226 pounds (at 66.90 per cent.), realized 2,504 tons 1,664 pounds of ingot, while the same product at the percentage of April, 1887 (78.21), would have given 2,928 tons 541 pounds of ingot copper, the real article to be sold in the market.

The Osceola mineral produces an average of 85 per cent. of ingot copper, the Quincy 83 per cent., Franklin 82½ per cent., and Tamarack 75 per cent. It would be an interesting point if some one conversant with the causes of these differences would explain the advantages of the higher percentages by the mines named.

MONTHLY PRODUCT, MINERAL AND INGOT.

	1886-7.		1887-8.		1888-9.		1889-90.	
Months.	Tons.	lbs.	Tons.	lbs.	Tons.	lbs.	Tons.	lbs.
May, min.	2693	1571	2681	778	2715	1908	3059	539
Per cent.	78.38		77.35		76.05		68.32	
Ingot....	2111	907	2073	1914	2065	956	2090	1717
June, min.	2843	583	2997	813	2660	853	2753	31
Per cent.	77.70		76.14		74.49		67.74	
Ingot....	2209	354	2282	253	1981	1625	1864	1356
July, min.	2836	777	2746	1478	2895	264	2820	1215
Per cent.	76.96		76.10		74.64		65.96	
Ingot....	2182	1502	2090	685	2160	1867	1877	51
Aug. min.	2895	1518	*1401	1949	3204	668	2936	414
Per cent.	77.07		74.26		73.61		65.78	
Ingot....	2231	1237	*1040	1561	2358	1494	1913	1454
Sep., min.	2800	1024	2100	596	3254	886	3126	1449
Per cent.	77.74		76.17		72.12		67.08	
Ingot....	2246	1946	1599	1664	2347	290	2097	1053
Oct., min.	2556	1769	3056	1737	4151	1684	3621	260
Per cent.	78.42		77.37		70.80		65.56	
Ingot....	2005	279	2365	477	2939	1071	2384	416
6 months.	16716	1192	14984	446	18882	258	18326	1908
Per cent of Ingot...	77.69		76.43		73.37		66.70½	
Ingot, ton.	12987	235	11452	554	13853	1303	12225	47
Nov., min.	2474	1422	2398	950	3816	1997	3526	1052
Per cent.	77.98		76.65		70.17		65.28	
Ingot....	1929	1542	1838	808	2678	1019	2302	451
Dec., min.	2738	1370	1579	1302	2763	1596	3496	470
Per cent.	78.90		76.82		70.45		66.19	
Ingot....	2161	142	1213	954	1947	354	2314	267
Jan., min.	2693	1221	1887	1765	2761	1612	3172	119
Per cent.	78.76		75.46		69.50		67.46	
Ingot....	2121	726	1424	1241	1913	1659	2139	1697
Feb., min.	2504	161	1915	280	2555	135	3174	95
Per cent.	78.18		73.30		66.89½		67.31	
Ingot....	1957	1426	1415	667	1708	906	2136	682
Mch., min.	2907	923	2400	1478	2992	1786	3555	830
Per cent.	78.05		76.39		67.35		66.69	
Ingot....	2269	826	1834	68	2015	1429	2370	1937
Apr., min.	2755	1978	2583	1291	2750	1799	3744	226
Per cent.	78.21		77.20		67.43		66.90	
Ingot....	2155	739	1994	1069	1854	1537	2504	1664
Year, min.	32791	267	27749	1512	36523	1203	38995	700
Per cent. of Ingot.	78.01		76.30		71.11		66.65½	
Ingot, ton.	25581	1626	21172	1451	25972	207	25993	745
Ingot, lbs.	51163	626	42345	451	51944	207	51986	745

* Fire in mine, and has continued much of the time since, the product coming mainly from the new workings.—*Boston News Bureau.*

Action of Lightning upon the Human Organism.

A Vienna paper states that Professor Nothnagel, in one of his clinical lectures, exhibited to his hearers a young woman, aged 20, Josepha Schleser, who had been recently struck by lightning in Styria, and had come to Vienna for treatment in Professor Nothnagel's hospital. The patient suffered from a derangement of the nervous system. To his remarks on this case the lecturer added a discourse on the effects of lightning, substantially as follows: Formerly it was known merely that the burns occasioned by lightning had a zigzag figure, and that the further consequences might be paralysis or death. During the last ten years the lecturer had made comprehensive experiments upon rabbits, with the electric spark of a large Leyden jar, and has thrown a new light upon this question. The action of lightning upon the brain, the spinal column and the peripheric nerves, is shown by the loss of consciousness, the disturbance of the intellect and the extended phenomena of lameness, the latter of which have a tendency to disappear. On the other hand, there are intense nervous phenomena which strongly resemble those produced by railway accidents and other concussions, and which dominate the patient for a long time. Disturbances of sight and speech often occur, and may remain for life, or may in part disappear. In other cases there may be observed in the person struck a childish frame of mind which may incline either to reckless merriment or to sadness and melancholy. Experience proves that lightning produces its chief effects only at the points of its entrance and exit. Thus a flash which entered a schoolroom injured only the first and last child on the form, those between escaping unhurt. Professor Nothnagel pointed out that in the treatment of lameness and other constitutional perturbations due to lightning, metallotherapy is most efficient, a large horseshoe magnet being applied alternately to the head, trunk and the limbs. This process led to better results than the electric treatment recently adopted. In case of a quite recent stroke, the clothing should be unfastened, the patient laid with the head high, quietness and fresh air should be secured, and if consciousness does not return, the head should be exposed to a stream of cold water.

Electric Lighting in Brooklyn.

The local press of Brooklyn is just now claiming that electric light circles will soon be stirred up over the question of competition in incandescent lighting. The *Eagle*, of that city, says:

The Citizens' Company, a corporation controlled by a few powerful Democratic politicians, headed by John Delmar, the president, is the aggressor. The Edison Company, a corporation to which the common council was compelled, through the force of public sentiment and political expediency, to grant a franchise, a few years since, is to receive the attack. It looks as if the political electricians mean, if possible, to crowd their rivals to the wall. The Edison Company furnishes the incandescent light only, and uses the system which bears the name of that great inventor. The Citizens' Company furnishes, for the most part, the arc light, such as is used for the illumination of our streets. It also furnishes some incandescent lights, though not to an extent which materially interferes with the other company. What it now proposes to do is to invade the entire domain of the Edison people with the incandescent light of the Westinghouse alternating system. The Edison Company is restricted to the Edison system, while the Citizens' has acquired or will shortly acquire the Westinghouse rights, and claims that the very cheapness of the alternating system must bring over much of the business controlled by the former company. Arrangements for the introduction of the Westinghouse system have been quietly progressing for some time past and are approaching completion.

The men in the Citizens' Company are not very communicative as to the details of their plans, but admit that they are going into the incandescent business on an extensive scale. They have facilities, money and influence, and their manner indicates that they feel they are on the way to greater fortune.

Over in the Eastern District, the Municipal Electric Light Company is furnishing the incandescent as well as the arc light. The Edison Company does no business in that section of the city, although it has the right to go there. In view of the plans of its rival in the Western District, however, it will not do anything there, for it will have its hands full here.

The latest electric light combination, the company in which Noah Cocheu, Mirabeau L. Towns and a few others figure, is not likely to get through the common council very soon. In fact, old and careful observers of affairs about the City Hall say that if they were going to bet, they should bet that the aldermen will never grant the franchise. There has been an impression that a number of the leading men in the old companies are interested in this new venture. Such does not seem to be the case. Rumor has it that a certain man, formerly a large, but at present a small, stockholder in the Municipal Company, is interested in the Cocheu-Towns combination. He is not as solid now with the controlling spirits of the Municipal Company as he once was, and this may account for his appearance in the latest deal.

A change in some of the officers of the Municipal Company is said to be imminent.

Experiments on Transformers.

AN ENGLISH CRITICISM.

Professor H. J. Ryan has been continuing his well-known researches into the action of transformers. He, or rather, Mr. L. B. Marks, used an experimental ring transformer with a core made of iron wire 1.1 c. m. thick. On heating the transformer the waste of power decreased. Of course, if such thick wire as this is used, the heating by Foucault currents is enormous, and, as Professor Ryan points out, heating, by increasing the specific resistance of the iron, lessens the waste. The loss of power by Foucault currents in such a core can be determined if the specific resistance of the iron is known. It does not in the least follow from this that transformers should be run hot.

Messrs. Calvin Humphrey and William H. Powell are also following Professor Ryan's good example, by reading a paper before the American Institute of Electrical Engineers, on tests of a 40-light converter. They use Ryan's arrangements for tracing the curves. The results are very good, but somewhat too good. The hysteresis loss appears impossibly small. We would suggest that there are errors arising from the use of incandescent lamps. The experimenters have, as far as we can judge from the report, calibrated lamps at varying resistances, and have then dealt with the instantaneous of their electro-motive forces, and taken the resistance as being the same as that produced by an equal continuous electro-motive force. The current readings so obtained would be too low, and would make the efficiency too high. For instance, if a lamp with 100 volts took an ampere, and with 50 volts .3 ampere, and the lamp during a test had 100 volts and 1 ampere, an instantaneous electrometer reading at a particular phase of 50 volts should be taken at .5 ampere, not .3 ampere. We only suggest this source of error; we cannot accuse the writers of making this slip, without seeing the paper in full.

The Foucault current component of the primary current also appears suspiciously wrong. In a transformer whose secondary terminal electro-motive force is co-phasedly synchronized with the primary electro-motive force, the Foucault current component is also. If the secondary terminal electro-motive force lags, the Foucault component lags somewhat less. The authors show it leading.—*London Industries.*

New Work of the Connecticut Motor Company.

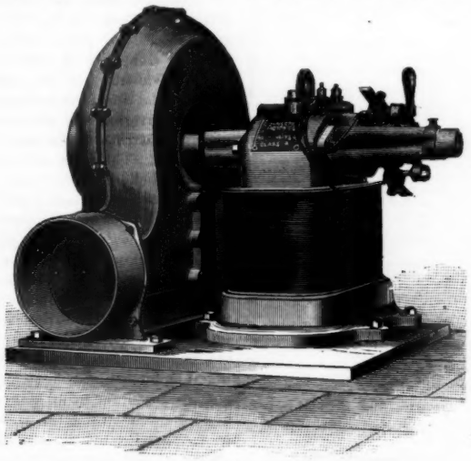
The accompanying cut illustrates a combination apparatus recently gotten out by the Connecticut Motor Company, of Plantsville, Conn.

It consists of a No. 2 Sturtevant centrifugal blower—exhaust or pressure, according to purpose—fitted to the base of a one horse-power Connecticut motor, with the armature shaft of the latter extended through the shell or blower, and the float wheel keyed to the same.

This arrangement is particularly compact, besides doing away entirely with belting, countershaft and pulleys, as would be the case if a blower had to be run from shop shafting.

A curved float wheel is used, by means of which the humming sound, usually so noticeable, is greatly subdued. While originally gotten out for the ventilation of engine rooms on steamships, a variety of uses have since proposed themselves, such as the ventilation of churches, theatres, etc., through the heated season, in foundries for urging the blast, and also for forcing draft under boilers.

It must be borne in mind that this combination is open for use in any locality where there are straight incandescent circuits, such as the Edison, or even an electric street railway may supply the current. Some useful data are given:



NEW MOTOR OF THE CONNECTICUT MOTOR COMPANY.

Speed, 2,000 revolutions.
Energy required, one horse-power.
Pressure per square inch, 2½ ounces.
Cubic feet per minute, 1,138
Diameter of outlet, 7½ inches.
Square feet of boiler grate surface it may pad, 10.

JEST FOR FUN.

An old man would not believe he could hear his wife talk a distance of five miles by telephone. His better half was in a shop several miles away, where there was a telephone, and the skeptic was also in a place where there was a similar instrument, and, on being told how to operate it, he walked boldly up and shouted:

"Hello, Sarah!"

At that instant lightning struck the telephone wire and knocked the man down, and, as he scrambled to his feet, he excitedly cried, "That's Sarah, sure as fate!"—*Chatter.*

THE POPULARITY OF THE YELLOW COVER.

A short time ago we received a letter from a correspondent in West Virginia. The opening paragraph reads like this:

"Please find enclosed ten cents for No. 20 of the REVIEW. We have a goat on the premises, and he got in his work on the last copy before I did. He is very fond of literature, and especially the REVIEW. I suppose the yellow cover catches his eye."

A TELEPHONE BREATH.

Mistress—Bridget, the telephone is ringing and I wish you would answer it.

Bridget—An' me afthur atin' onions fur me dinner. Sure, Oi'll do nothin' of the sort, for who knows but fwhat it bees the yoong man as delivers the groceries.—*News Letter.*

Sanford, Fla.—The DeLand Electric Light and Ice Company; capital, $150,000.

Goldsboro, N. C.—Goldsboro Electric Light and Power Company; capital, $25,000.

Three Rivers, Mich.—Three Rivers Electric Light and Power Company; capital, $50,000.

Chicago, Ill.—Underground Electric Light Company; capital, $1,000,000. Incorporators, A. J. Cooper, F. J. O'Connor and C. A. Munson.

Jeffersonville, Ind.—The New Albany and Jeffersonville Electric Railway Company; capital, $150,000. John M. Stotzenburg is president.

Newark, N. J.—The Edison Industrial Works; capital, $1,000,000. Incorporators, Thomas A. Edison, Samuel Insull, Thomas Butler and Slierborn B. Eason.

Chicago, Ill.—Dyer Electric Company; to manufacture, sell and license for use, the Dyer electric system; capital stock, $10,000,000; incorporators, J. T. Dyer, H. S. Dickson and C. W. Huddleston.

Chicago, Ill.—United States Electric Car Company, to manufacture electric cars and motors, and operate the same; capital stock, $3,000,000; incorporators, M. S. Debolt, J. H. Donnelly and John A. Qualey.

Chicago, Ill.—Chicago Novelty and Electrical Company; to manufacture and deal in novelties and electrical goods; capital stock, $50,000; incorporators, Foree Bain, Matthew Hurton and J. W. Hutt.

Pelham, N. Y.—The Pelham Bay Park Electric Light Power and Storage Company has been incorporated, with $10,000 capital. The trustees are, George W. Cochran, Edward S. Becker and Benj. Franklin.

Leavenworth, Kan.—The Citizens' Electric Railway Company; capital stock, $300,000. Directors, W. D. Kelly, J. W. Folger, L. Hawn, W. N. Todd, W. B. Nickels, E. A. Kelly, Otto H. Wulfekuhler.

Jersey City, N. J.—The New Jersey Investment Company will manufacture and put in place electric light. The principal office in New Jersey will be at Jersey City. Operations will also be carried on in Mexico. The capital stock is $1,200,000.

Seattle, Wash.—Bellingham Bay Electric Street Railway Company; with a capital stock of $300,000, and the following officers: Eugene Canfield, president; P. B. Cornwall, vice-president; J. W. Morgan, treasurer; C. W. Dorr, secretary, and C. D. McKelar, superintendent.

Seattle, Wash.—Metropolitan Electric Railway Company; incorporated by Jacob Furth, A. B. Stewart, J. M. Thompson, H. G. Struve, G. H. Heilbron, J. C. Haines, F. G. Grant, Bailey Gatzert, A. P. Mitten, J. P. Hoyt and Maurice McMicken. The capital stock is $3,000,000.

Philadelphia, Pa.—The Electric Engineering Company; the objects are to construct electrical railways, cars, etc. Harvey Barton, Henry Gianella, Christian Schneider and Thomas Marion, of Philadelphia, and Charles Richter, of Camden, are the incorporators. The capital stock is $100,000.

Richmond, Va.—The Traylor Electric Company; capital, $300,000. The officers for the first year: A. W. Garber, president; Thomas Potts, vice-president; J. E. McKinney, secretary; Meredith F. Montague, treasurer; R. W. Traylor, superintendent; and the following directors: A. W. Garber, J. Taylor Ellyson, J. L. Taliaferro, Wirt E. Taylor, R. F. Hudson and Thomas Potts.

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How do you like the REVIEW this week? It is full of meat.

Lots of newspaper paragraphs start in with the announcement, "A report is current." It doesn't need an electrician to dispute that assertion.

By the time this issue of the ELECTRICAL REVIEW reaches its readers, the sentence of electrocution will, in all probability, have been carried out upon the murderer, Kemmler, in Auburn prison.

In this issue will be found the first installment of the paper by Prof. W. E. Ayrton and his associates, upon the secondary battery. We believe the subject is treated from an entirely new and unprejudiced standpoint and is, therefore, of additional interest and value.

The London *Times* has shown its supremacy in the newspaper world, during the past week, by its magnificent telegraph service from Buenos Ayres. It is the only newspaper in London which has a correspondent in the capital of the Argentine Republic, and has spent over $30,000 during the past week in telegraphing daily the story of the revolution. Cabling is $1.75 a word, but its dispatches have been very complete and graphic.

The inhabitants of Clamecy, France, have dealt in a very spirited manner with the Paris gas company which owns the gas works at the first named town. The gas company having refused to lower its exorbitant rates, no less than 87 of the principal merchants of the place formed an association and bound themselves to abandon the use of gas from a certain day of this month, and a committee was appointed for the immediate organization of an electric lighting company to supply a substitute for the discarded illuminant.

AN ASPERSION ON THE PATENT OFFICE.

The *Western Electrician*, in its issue of July 26, went gunning for the Patent Office, and called attention in its columns to two recent patents, Nos. 432,131 and 432,279, for a current regulator or rheostat. In the judgment of the editor of our esteemed contemporary, these two patents seem to be identical, and in his editorial columns the Patent Office was accused of "most startling looseness and mismanagement." Our contemporary should be careful not to carry a gun with a hair trigger. Its abuse of the Patent Office seems to be entirely unwarranted. In a bureau of government, in which comparisons must obviously be made between inventions differing only in specific details, it is quite natural that occasionally patents should be issued bearing a very close resemblance. The smallest differences in structure of apparatus are sometimes of very great practical importance, and these differences are defined with so much vigor by the inventors and their attorneys that the full records of the cases will ordinarily render as plain as daylight distinctions which would not be apparent on a mere perusal of the claims of the patents. The cases in point, however, do not require an examination of the full records in order to show up the differences between them, and the aspersion upon the character of the Examining Corps of the Patent Office is groundless. The Patent Office Examining Corps is composed of some hundred and fifty individuals, and we believe that nowhere in the world can be found a scientific body in governmental service composed of units so uniformly industrious, careful, able and honest. The cases referred to present a marked similarity in the drawings and that is all. The claims—the soul of patents—and the parts thereof in which the particular matter claimed by the inventor as his own is specifically disclosed, differ. The case in point is one in which two men have evidently been associated in producing an electrical instrument. If the instruments were absolutely identical, the course to be pursued by the two inventors in securing protection might be by making a joint application for a single patent, or by making each his own application describing the whole instrument as a completed article, and addressing his claims to such portions thereof as were of his own individual invention. The two rheostats described in these patents differ, however, in structure—they are not one and the same machine. If the editor of the *Electrician* had read the claims carefully he would have noted this. The two patents simply involve the question of *species* and *genus*, certain features of the invention having been the common property of two individual inventors, but the details being the exclusive property of one or the other. A careful perusal of the claims in the two cases is sufficient to enable any one familiar with the legal construction put upon patents to appreciate the differences. It cannot be expected that the ordinary reader can always do this. Naturally, where differences are so fine, as they must be in this age of specific improvement, expert knowledge must be brought to bear in order to appreciate fully the scope and differences of two or more patents relating to the same type of machine. To say that because of this, two inventors should not be given independent patents because they bear general points of resemblance, would be to put an embargo upon invention and check industrial growth by destroying the delicate refinements of apparatus for which the present age is so remarkable. We have abundant reason to be proud of our Patent Office; faults there are in the patent system, but they are incidents of the statutes controlling its operation, and of niggardly legislation in relation to office facilities; they are not traceable to the *personnel* of the Examining Corps.

We give in another place the programme which will be followed at the Cape May Convention of the National Electric Light Association. The meeting will be on Tuesday, August 19th, and it is expected by Thursday evening business will be finished. It will be noted that the place and hours of the Convention are most agreeably arranged. The papers will be interesting, and altogether we look for a large attendance.

RECENT NOTABLE ELECTRICAL PATENTS.

ELECTRIC RAILWAYS.

Frank Mansfield, of New York, has been granted several patents for electric railway systems, dispensing both with overhead conductors and with underground conduits. These operate on the spot system. A continuous well insulated conductor is buried in the ground and short branch conductors run from there to the road-bed at short intervals along the tracks, but contact is open at all times except when a car is passing over any particular spot. An electro-magnet, or any suitable mechanical contrivance carried by the car, is used to lift a pivoted arm in a box in which these contacts are arranged, which not only closes the connection between the supply conductor and branch, but establishes also a sliding contact with a rail mounted on the underside of the car. The current returns through the motor and rails to the supply station. This seems to be a neat solution of surface transit; dispensing with expensive conduits and overhead wires. As the car passes along over the track it cuts its motor into circuit first at one contact spot, and then, before breaking connection with that spot, establishing connection with another. Nothing is in sight along the track except occasional spot boxes where the connection is to be made. In case a mechanical device is used to lift the arm at the contact spot and establish connection, a middle guide rail is used, and the contact arm has a lug resting in a slot in the rail; a pendant plough on the car rides under the lug and lifts the arm, being guided accurately to the right place by the guide rail.

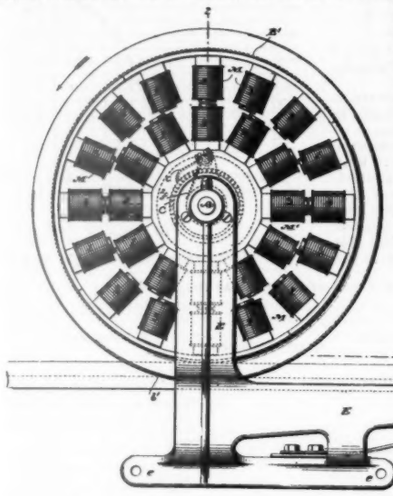
SUPPLYING HYDRO-CARBON VAPORS TO ARC LIGHTS.

Mr. L. Saunderson, of Dublin, Ireland, has patented a hollow carbon, the cool end of which is immersed in some liquid hydrocarbon and is provided with a tightly fitting plug of fibrous material. Above the plug is a thread of asbestos which extends to the burning point of the carbon. The hydrocarbon vapors rise through the hollow center and it is claimed increase the brilliancy of the arc. The thread of asbestos prevents the closure of the hollow center by fusion at the point where the arc is formed.

TELPHERAGE OR ELECTRICAL TRANSPORTATION.

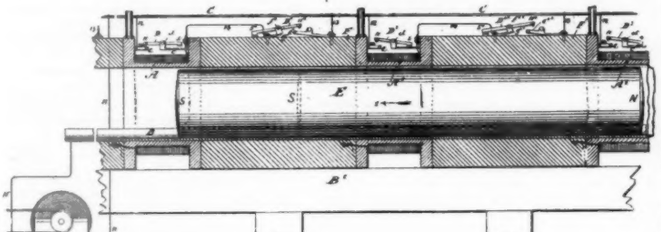
A. L. Parcelle, of Boston, Mass., has patented a motor for running upon an overhead rail, in which the power is applied directly to the axle, and of which a fair idea may be gathered upon inspection of the accompanying illustration. An U-shaped rail, *R*, supported on suitable posts is used, the open portion of the rail being turned downward. The motor wheel, B^1, is grooved, its flanges embracing the rail. A circumferential series of electro-magnets is secured to the wheel on its inner side, and co-operates with a series of magnets secured to the frame of the motor. The cores of the magnets are of such a length as to bring the poles of the movable series into close relation with those of the fixed series as the wheel rotates. Two commutators are provided, one of which is carried by and moves with the rotating wheel, and one of which is fixed to the frame of the machine. A roller, E^2, carried by an insulated arm secured to the frame, rolls upon an insulated conductor secured within the U on the underside of the rail, and takes the current from such conductor, whence it is led in multiple arc through the two commutators, one branch supplying the field magnet coils successively in groups, and the other branch supplying the armature coils successively in groups. There are four coils to each group, so that when any strip of the commutator is in contact with its co-operating brush, four coils are connected in circuit. The exciting coils of the electro-magnets are so connected that they will be cut in by their commutators in groups when they reach a position of maximum pull. As illustrated in the drawing, the series of magnets marked 1 in the armature and field magnet are connected in circuit, these magnets being in about the position of maximum attractive

effort. When the wheel, B^1, moves with reference to the fixed magnets a short distance—sufficient to bring the corresponding groups of coils marked 2 into a position where the maximum pull would be exerted—the commutator strips corresponding to coils 1 will be cut out of circuit, and those

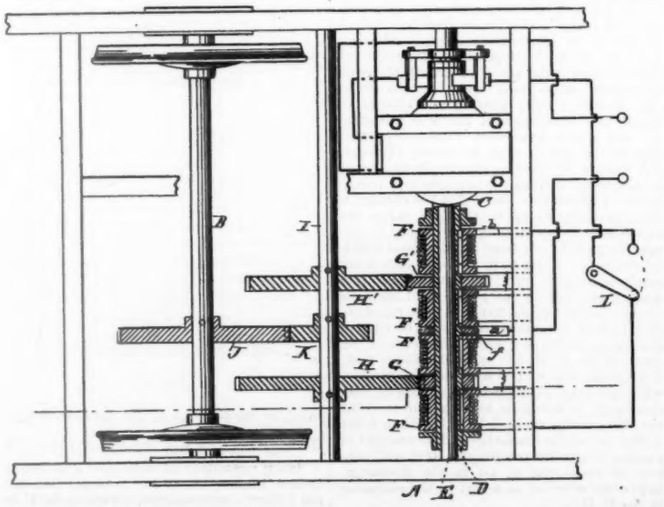


corresponding to coils 2 will be cut in; the current thus being shifted by the action of the commutator through the successive co-operating groups and causing a continuous rotation of the wheel. The frame of the motor, E, is extended rearwardly, and carries a grooved wheel, E^1, for steadying the motor on the rail.

John T. Williams, of Mount Vernon, N.



Y., has patented a system of package transmission, in which the carriage is made of steel and permanently magnetized, so that one of its ends is of north and the other of south polarity. The carriage moves upon a conducting rail marked B in the accompanying illustration, within a continuous tube or conduit wound at intervals of its length with solenoid coils, A. On the outside of the



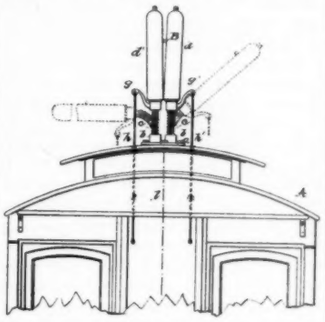
tube is fixed another conductor, C. The circuit is closed through the coils A, successively, by means of magnetized needles, D D', etc., which are normally out of contact with co operating contact studs e. When the end of the carriage S reaches any needle, the latter is magnetically attracted, so as to close the circuit through its coil, which then exerts a suction upon the magnetized carriage. In some cases auxiliary contact needles D^2, etc., connected with a coil some distance ahead are used, so that the needle will be given time to swing, and will have made its contact when the carriage arrives in the proper position with reference to the coil cut in to receive a maximum pull, thus providing for a swifter movement of the carriage than where the needles and their coils are arranged at the same point.

VARIABLE SPEED GEARING FOR ELECTRIC CARS.

T. M. Foote, of Boston, Mass., has patented a system of gearing for electric motors, in which the design is to preserve a uniform speed of rotation of the motor armature, thus permitting it to operate at maximum efficiency, irrespective of the speed of the car to which it is affixed, and preventing injurious heating of the motor coils, which is liable to occur in the ordinary existing gearing when the car slows down in ascending a grade, or performs extra work, and the counter electro-motive force of the motor is reduced. In the accompanying drawing, which illustrates the system, two pairs of coils marked F are splined to the armature spindle so as to permit sufficient longitudinal movement to allow them to be drawn into contact with gear wheels G G^1 when they are energized by a current. Gear wheels G G^1 are loose upon the spindle and co-operate with gear wheels H H^1 connected by a train of gearing with one of the car axles. The coils F are so connected that either pair may be connected in a shunt circuit around the motor by means of a switch L. As shown in the drawing, the right hand pair of coils are receiving current, magnetizing their iron spools and bringing them into magnetic contact with gear wheel G, thus locking or clutching this gear wheel to the armature shaft. If a faster movement of the car is desired, the switch would be shifted so as to unclutch gear wheel G and clutch gear wheel G^1 by cutting in the left hand pair of coils, the relative speed of the car in the two positions of adjustment being dependent on the relative sizes and number of teeth of the co-operating gear wheels G, H, G^1, H^1. The armature thus revolves at a uniform speed, whereas the speed of the car itself may be varied.

CONTACT FOR ELECTRIC RAILWAY.

Frank J. Sprague, of New York, has patented a novel contact for an overhead conductor. The idea will be understood from the accompanying illustration. Two



conducting rollers d d' are mounted on the top of the car and embrace the overhead conductor B. In passing a switch for a branch circuit at any point along the road, either roller may be pulled down by a connecting cord extending within reach of the motor man, so as to throw it out of the way of the divergent branch circuit.

TELEPHONE TRANSMITTER.

Mr. Stephen D. Field has patented a telephone transmitter, containing a self-acting thermostatic circuit breaker, the expanding element of which is a conductor of considerable resistance inserted in the primary circuit of the telephone and actuated by the current therein, co-operating with a diaphragm carrying one of the terminals of said circuit breaker, and a short circuit connected to said terminal and also to the primary circuit beyond the expanding element. In the normal primary circuit is a switch for disconnecting said circuit at will.

DYNAMO ELECTRIC MACHINE.

H. W. Spang, of New York, has patented a dynamo electric machine, in which the pole pieces of the field magnets are shorter in the direction of the axis of the armature than the armature core. It is claimed for this invention that it utilizes more lines of force than in cases where the pole pieces are as wide or wider than the armature core.

OUR BOSTON LETTER.

The Newton Street Railway Company, will, as soon as its electric cars are in regular operation, make the rate of fare five cents between Waltham and Newton, Mass.

Electric Railway to Somerville, Mass.—The work of laying the new tracks for electric cars from Bowdoin Square, Boston, to Somerville, is progressing rapidly.

Messrs. Paine & Francis, of this city, have a contract in hand to install two 500-light Edison dynamos in the Syndicate building on State street. The firm named are now wiring the building for 5,000 incandescent lights, and will furnish the entire electrical equipment for the plant.

New England Electric Exchange.—At the meeting of the executive committee, on Wednesday, July 16. Examinations were taken for ten first-class licenses, and since that date several new applications for examination have been made and will receive the attention of the committee at its next meeting, on July 30, at the rooms of the Boston Electric Club.

Electric Motors for the Mechanics' Fair.—Arrangements have been perfected by the managers of the Mechanics' Fair Association, of this city, with the Thomson-Houston Motor Company to furnish electric motors in any part of the Mammoth Mechanics' Fair Building, where power may be required. This will enable the managers of the fair to afford a more satisfactory arrangement of machinery than at previous fairs, and this will much facilitate the work of classification and assignment of space.

Boston, August 2. W. I. B.

OUR CHICAGO LETTER.

Mr. Geo. Cutter, general manager of the Great Western Electric Supply Company, accompanied by Mrs. Cutter and the Misses Gass, left Chicago for a trip to Boston on the Sea Side and White Mountain Special *via* the Grand Trunk Railway, on Wednesday last. The party will visit Niagara Falls, thence to Kingston, Canada, visiting the Thousand Islands, by boat up the St. Lawrence river to a point in Canada, where they will again board the "Special," speeding on through the White Mountains to Boston. After a short visit in that city, they will journey on to Cape May *via* New York city, arriving at Cape May August 16th, in ample time for the opening of the National Convention.

Mr. Chas. Ball, of the Ball Electric Company, of New York, was registered at the Sherman House last week.

Much Interest is shown, and extensive preparations are being made by prominent supply houses and manufacturers, for a display at the St. Louis Exposition, which opens in that city September 3d. Judging from the space secured, the exhibit will surpass anything of the kind ever seen in the West, if not in America.

F. E. Degenhardt is again at his office, after a severe illness of two weeks. Mr. D. will spend his summer vacation at the sea shore, and will leave about August 10th.

The Great Western Electric Supply Company are putting on the market armatures and intermediate pinions, composed of a substance entirely new, which gives a noiseless pinion, and at the same time gives a long and satisfactory life. The company believe that a trial order will mean constant use. The above company have recently been appointed agents for Brown's electric protector for use on telephone circuits, protecting same from the evil effects of lightning and crosses.

Mr. Chas. G. Armstrong who has charge of the house goods department for the Great Western Electric Supply Company, has just returned from a business trip through the East in the interest of the above concern. While in the East, Mr. Armstrong made arrangements for handling the superior line of goods manufactured by the National Electric Manufacturing Company, together with other concerns of equal reputation.

Daniel C. Hemingray, of the Hemingray Glass Company, of Cincinnati, Ohio, was among the recent visitors in the city.

The Electrical Supply Company have hit on a novel plan for producing cool breezes in their offices. Suspended from the ceiling by wires is a small motor on which is carried an 18 inch fan, this making about 2,000 revolutions per minute keeps a nice circulation of air through the office.

The Central Electric Company have perfected arrangements with the Electricians' Time Company to supply the trade with all styles of watches, ranging in price from $10 upwards. These watches are protected from the evil effect of magnetism by a guaranteed non-magnetic shield. In a circular put out by the company they offer these watches to the trade on the installment plan, paying 25 per cent. list price down and balance in three equal semi-monthly payments; each order must be accompanied by a guarantee from employers. The watches are within the reach of all, and by paying for same on the installment plan the buyer hardly feels the purchase, at the same time gives those a chance to buy who cannot afford to pay cost price in one payment.

J. H. Reid has resigned his position as manager of the western office for the Mather Electric Company and will open a suite of offices for the Easton Electric Company. Mr. Reid's position with the Easton Company will be that of general manager.

Paul W. Bossart, who is well-known to the electrical fraternity throughout the West, has accepted a position in the railway and motor department of the Detroit Electrical Works. D. B. D.

Chicago, August 2.

PERSONAL.

Hon. Chas. S. Gleed, Attorney of the Missouri and Kansas Telephone Company was an eastern visitor last week, hobnobbing with telephone and railroad magnates of the Atlantic coast.

Col. Gardiner C. Sims, of Providence, will represent Rhode Island at the World's Columbian Exposition in '92. If men of such calibre represent every State in the Union, the success of th exposition will not be in doubt.

We present in this issue an illustrated article describing the automatic or "nickel-in-the-slot" phonograph. This machine will prove a great institution, we predict. It will be a source of education as well as of amusement. There are lots of people who have never heard a phonograph talk except in a public hall. The advantages of hearing a great speech or a portion of an opera, and having it "all to yourself" are easily imagined.

Telephonic News

⁂ At the annual meeting of the Tropical American Telephone Company, held at Long Branch, N. J., the following directors were chosen: Chas. Williams, Jr., Col. H. S. Russell, Dr. E. P. Bradbury, Jas. H. Howard, Frank W. Harrington, of New York. The report of the general manager showed business 50 per cent. in excess of the year before. Stockholders recommended resumption of dividends, and also an extra. Questions of amount of dividends to be paid will be decided at the next directors' meeting.

⁂ After numerous conferences, which have extended over the past three months, the English government has finally decided against purchasing the telephone system now operated by existing companies. This decision has been arrived at in spite of the strong pressure in the direction of inducing the government to add a telephone service to the telegraphic department. The government, however, has decided that upon the expiration of the patents controlled by the National Telephone Company, it will issue licenses to all new companies applying for them provided they are able to satisfy the authorities of their ability to carry on the work. In this way the public will be insured the benefits of competition.

Accident at the Western Union Building.

The wooden chute, on the Dey street side of the Western Union building, became clogged with *debris* on July 30th. Two laborers were standing on braces running out from the building to the chute, trying to free the jam. A barrel, which was being drawn to the top of the building, struck one of these braces, precipitating the two men and a large section of the chute to the street. One of the men died in the ambulance on the way to the hospital. The other is not dangerously hurt.

Telephonic Communication Between London and Provinces.

Our London namesake states that on the 11th inst., a wire to London, which was completed late the previous night, was tested at the offices of the National Telephone Company, Faulkner street, Manchester. Alderman Thompson, who was attending a meeting of the directors of the company at the Cannon street hotel, in London, and other gentlemen held conversations with representatives of the Press and others in Manchester, and not only were the words uttered heard quite clearly, but the tones of each voice were recognisable. The new wire, we understand, extends from Sheffield to London, and terminates at the office of the company, Oxford Court, Cannon street. There is already existing a wire from Sheffield to Manchester, and the two wires were placed in circuit. The gentlemen at the offices of the company in Faulkner street, Manchester, were thus enabled, with the most perfect ease, to speak to officers of the company in London. Colonel R. R. Jackson, one of the vice-presidents of the company, was one of the gentlemen in London who conversed with representatives of the Press in Manchester. London to Manchester is 221 miles; to Liverpool *via* Manchester, 266 miles; to Sheffield, 195 miles; to Bradford, 252 miles; to York, 275 miles; and to Leeds, 252 miles. It is expected that in the course of a fortnight the London wire will be available for the use of the members of the Exchange in Manchester. Telephonic communication between London and Liverpool was also established last week. Messages were first exchanged between the Mayors of Liverpool and London, and during the afternoon several commercial messages were transmitted. The opinion of those who tested the telephone, was that, though 200 miles separate, London and Liverpool messages will be as distinctly heard as if they were transmitted between the local centers.

THE WORKING EFFICIENCY OF SECONDARY CELLS.

BY W. E. AYRTON; C. G. LAMB, E. W. SMITH AND M. W. WOODS, ASSOCIATES.—READ AT MEETING OF INSTITUTE OF ELECTRICAL ENGINEERS, EDINBURGH, JULY 16TH, 1890.

I.—PREVIOUS TESTS OF CELLS.

Since 1881, when the formation of Plante storage cells was greatly accelerated by Faure's device of pasting the plates, numerous tests have been made in different parts of the world on the capacity and efficiency of secondary cells. The first tests that were carried out were conducted simultaneously, at the end of 1881, in England, by Professor Perry, with one of the authors of this paper, and in France by a committee consisting of Messieurs Tresca, Potier, Joubert and Allard, working at the Conservatoire des Arts, at Metiers, with a staff of assistants.

In the report—communicated to the Physical Society, in February, 1882—by the two English experimenters, it was pointed out that the great "resuscitating power" of the cells made it very difficult to say when they were entirely discharged, and, therefore, in order to test the efficiency, the cells were first "emptied" of charge by discharging them until the discharge current was very small, and, finally, leaving them short-circuited for many hours with a short bit of thick wire. Next, a measured amount of energy was put into these "empty" cells, and they were then thoroughly discharged on three successive days, being insulated and allowed to recuperate during the two intervening nights. Although the energy efficiency thus obtained, and which was not less than 82 per cent., probably represented much more than could be obtained in practice at that period, if the discharge were stopped before the E. M. F. fell to so low a value, this efficiency represented something quite definite, since all the energy given out by the cells in the discharge must have been put into them during the measured charge, no demand being made on some inexhausted store of energy previously put into the cells.

The French committee, on the other hand, considered the cells as being discharged when a certain current which was originally produced through a fixed resistance by 30 cells, could no longer be kept up, even when the number of cells had been increased to 35. But unless, subsequently to the receipt of the cells from the manufacturers, they had been charged and discharged several times until the same cycles of values of E. M. F. with time were repeated with each charge and discharge, there was no guarantee that in the experimental discharge the cells were not drawing on a store of energy put into them before leaving the manufacturers' premises and thus giving a higher value than the "working efficiency."

And we are afraid that a very possible neglect of the powerful resuscitating power of accumulators may have vitiated some of the published results of experiments that have been made on them. This doubt must not be forgotten in considering the accompanying list, which is as complete as we have been able to make it, of all such experiments that have been made up to date. At the middle of 1889, when we had nearly completed our investigation, there appeared two very important contributions to the subject—one on "The Inherent Defects of Secondary Batteries," by Dr. Louis Duncan and H. Wiegand; the other, "Ergebnisse von Versuchen an Akkumulatoren für Stationsbetrieb," by Prof. W. Kohlrausch and C. Heim. These investigations are extremely interesting, as they confirm some of the results which we had also arrived at, and to which reference will be made in this paper; Prof. W. Kohlrausch and C. Heim, for example, laying great stress on the fact that the discharge of an accumulator does not depend merely on the previous charge, but on the previous history of the cell.

At the Central Institution there are three distinct types of E.P.S. cells in daily use. The cells, however, used by us for the investigation were 20 out of a group of 50 of what is known as the 1888 type. This type we selected since it was the latest constructed by the Electrical Power Storage Company. The particular specimens of this 1888 type, which are at the Central Institution, contain each two positive and three negative plates, each plate, exclusive of the lugs, being 9¼ by 9¼ inches. The glass vessels containing these plates are large enough to each hold 7L plates, but we preferred to use 7L glass boxes to having smaller boxes specially constructed.

The total weight of each of these cells is about 59 lbs. 12 oz., made up as follows:

	lbs.	oz.
3 negative plates.....about	17	2
2 positive " ..... "	11	8
Ebonite strips ..... "	0	8
1 glass vessel..... "	7	8
Dilute sulphuric acid.. "	23	2

and the cells are intended to be used with a maximum current of 9 amperes on charging and 10 on discharging.

The first point to settle with reference to the discharge was whether the resistance in the circuit should be kept constant, or whether as the E. M. F. fell the resistance should be varied in such a way as to keep the current constant. This latter method, although it involved much more labor, was adopted. At first the current was kept constant by varying the resistance by hand as the E. M. F. of the cells altered. But this required the constant presence of one of the observers day and night, partly to vary the resistance from time to time, and partly to start the charging directly the discharging was finished, in order that the cells might never be left discharged. Hence an automatic arrangement, which will be described later on, was subsequently devised, and by means of it the current was maintained more constant than could be achieved by even very careful hand regulation, and the circuit broken during discharging and during charging the moment the P. D. reached certain pre-arranged values.

We had next to adopt a criterion by which to settle when a charge or discharge could be said to be completed. Such a criterion may be made to depend on a variety of changes that take place in a cell, three of which are in common use—viz, change in the specific gravity gassing and change in the P. D. In the case of the cells tested by us, and which have more liquid in proportion to the plates than is usually the case, the change in specific gravity from charge to discharge is from 1.2 to about 1.17; and, as our experiments show that the change is directly proportional to the time, when the current is kept constant, the change in the specific gravity per hour is only about 0.002, which is far too small to be read very accurately with ordinary hydrometers. But it is known the fall in the E. M. F. of the cells at the ends of the discharge is very rapid, so that half an hour more or less in the time of discharge produces a great difference in the value of the E. M. F.; hence it follows that, if a specific gravity test were alone employed, with our cells as a criterion of charge and discharge, it would be necessary to read the specific gravity accurately to less than 0.001 at the end of the discharge. The amount of gassing is also far too rough a test, and cannot be employed at all in the discharge, hence we were led to resort to the variation in the P. D.

A number of experiments were now made on two of the cells in order that the *exact* shape of the curves of P.D. at the *end* of the charge and discharge might be ascertained. The curve shown in Fig. 1 is the end of the P.D. curve for one cell on charging with nine amperes for 14 hours; from which we see that the rate of variation of the P.D. with time is greatest when the P.D is about 2.36 volts, indicated by the point *A*. In Fig. 2 is shown the curve of P.D. during

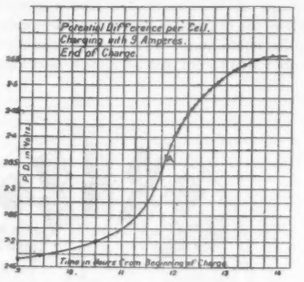


FIG. 1.

the last 3½ hours of a discharge with 10 amperes, the discharge being continued for 12 hours. In this particular experiment, the discharge was allowed to continue until the P.D. fell to 1.365 volts, indicated by the point *C*, which is far lower than we have dared on any other occasion to allow the P.D. to fall. At about 1.8 volts the P.D. curve begins to fall pretty rapidly, and the slope of the curve, or the rate of diminution of the P.D. with time, goes on increasing until the P.D. has fallen to 1.6 volts, indicated by the point *A* on the curve in Fig. 2. Here $\frac{dV}{dt}$ per cell has reached a value 1.4, V being measured in volts and t in hours. Below this the curve has a shape that has not hitherto been noticed, for when the P.D. per cell has reached 1.556 volts, indicated by the point *B*, the curve suddenly alters its shape, becoming the straight line *B C*, with a less inclination to the axis of time, $\frac{dV}{dt}$ being for this line only 0.44.

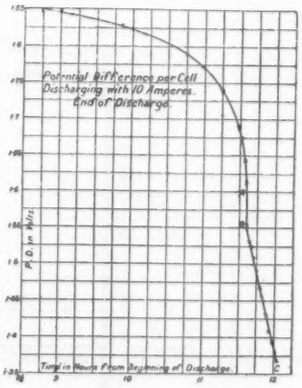

Potential Difference per Cell
Discharging with 10 Amperes.
End of Discharge.
P.D. in Volts.
Time in Hours from Beginning of Discharge.

FIG. 2.

Just as we have in the curve in Fig. 2 continued the discharge much below the usual

EFFICIENCY TESTS OF ACCUMULATORS.

Date.	Maker of Cell.	Experimenters.	Efficiency. Quantity.	Efficiency. Energy	REMARKS.
1882	Faure.....	Ayrton & Perry	.....	82	Cells short-circuited for some time before being tested. Cells discharged on three successive days, and allowed to recuperate during the two intervening nights.
1882	"	French Commission.....	92	70	Result of a week's work. Current kept fairly constant during discharge by the addition from time to time of fresh cells.
1883	Schultz.....	Hallwachs.	.....	6 to 50	Results variable and indefinite.
1883	E. P. S.....	H. Morton.....	90	.....	
1883	.....	Aron.....	.....	6 to 50	Results very variable.
1885	B. T. K.....	Forbes	80	69	Mean of one week's work. Current not kept constant.
1886	Farbaky & Schenek.	Waltenhofen	91.7	78.7	
1886	E. P. S.....	Drake & Gorham.....	90	80	Current maintained constant during charge and during discharge.
1887	.....	Haeberlin.....	92	.....	"Cells not good."
1887	Fitzgerald	Lea...	91	.....	
1887	.....	Huber.....	.....	88	
1887	C. Smith.....	Miller	80	.....	Lead spirals painted over with salts.
1888	Huber.....	W. Kohlrausch.....	90.7	78.4	
1889	Farbaky & Schenek.	Waltenhofen	88.1	77.4	
1889	Tudor	W. Kohlrausch & Heim.	94	82.4	Normal currents used in charging and in discharging.
1889	"	" "	77	64.7	Charging and discharging currents rather more than twice the normal.
1889	"	" "	81.4	71.7	Cells allowed to rest for 160 hours after charging.
1889	"	" "	90	80	Cells first completely discharged by the external resistance being gradually diminished to nought.
					The positive plates of these Tudor cells are first formed by Plante's process, then the holes in the grids are filled with minium, and the forming continued. The negative grids are not formed at all, but merely have the holes in the grids filled with lead oxide.

limit, so we examined what would take place if the charging was also prolonged much beyond the usual limit. Curve 3 shows the rise of the P. D. when the

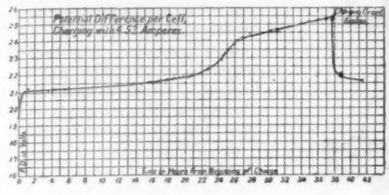


FIG. 3.

charging at 4.52 amperes was continued for 37½ hours, 25½ hours being sufficient to fully charge the cells with this constant current of 4.52 amperes—that is, to charge them until the P. D. per cell was 2.4 volts. It will be observed that whereas the volts rise from 2.25 to 2.38 between 23.1 and 25.5 hours—that is, 0.13 volt per cell in 2.4 hours—the rise in the following 12.3 hours is only from 2.38 to 2.55 volts; this is only 0.17 volt. The continuation of the curve shows the drop of P. D. on breaking the charging circuit; there is an instantaneous fall of 0.28 volt per cell, and a further fall of 0.1 volt in the E. M. F. in two hours.

The curve on Fig. 4 shows on a larger scale this drop on breaking the charging circuit when the cells are very well charged,

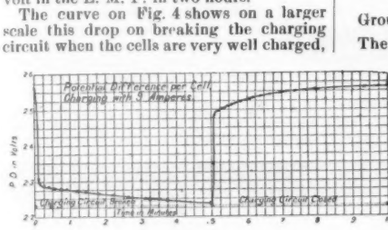


Fig. 4.

leaving it broken for five minutes, and then closing it again; the charging current in this experiment being nine amperes. There is, we see, a nearly instantaneous drop of the terminal P.D. per cell from 2.56 to 2.31, then a steady fall in the E.M.F. from 2.31 to 2.24 volts in five minutes. On reclosing the charging circuit at this moment, there is an instantaneous rise of the P.D. to 2.48 volts, and then a slow rise to 2.56 volts in five minutes; so that after reclosing the charging circuit, it took, in this experiment, the same time for the P.D. to recover the value it had just before breaking as the time during which the circuit remained broken.

Experiments were also made on the time rise of the E.M.F. on stopping the discharge. Later on, however, the time rise of the E.M.F. on breaking the discharge circuit, as well as the time fall of the E.M.F. on breaking the charging circuit, for various currents, was measured in a far more sensitive way than in the early part of this investigation; this subject will, therefore, be left until farther on in this paper.

On starting a discharge, the P. D. generally falls slightly to the value that is maintained fairly constantly during a long portion of a discharge. After a prolonged rest, however, we have found that the P. D., on the contrary, shows a *decided rise* at the commencement of a discharge, and that it is not until the third discharge takes place that the curve resumes its normal character with the slight drop in the value of the P.D. at the commencement of the discharge.

II.—EFFICIENCY.

In the earlier of the experiments made by us on the efficiency, two distinct groups, each of 10 cells, were employed. The current, passing through the two sets of cells, also passed through two platinoid strips, and the P.D. at the terminals of each of these platinoid strips was measured by a suitable low resistance galvanometer, whose indications, therefore, measured the respective currents passing through the two sets of cells. The P.D. at the terminals of either group of cells was measured by means of a high resistance D'Arsonval galvanometer, which, by means of a switch, could be connected with the terminals of either of the two groups. The high resistance, and one of the low resistance instruments, have been absolutely calibrated very frequently, during the past few years, by means of the silver voltmeter, known resistances, and Latimer Clark standard cells. A special calibration was also taken of these instruments, both just before these experiments were commenced and at their conclusion.

Group No. I. of ten cells, was first charged with 9.05 amperes and discharged with 9.933 amperes, there being four discharges alternated with four charges, without intermission, from January 8th to January 12th, 1889, both days inclusive. One of the observers was always present (day and night) to keep the current constant by hand regulation, to take frequent readings of the P.D. at the terminals of the set of ten cells, to stop the charging when the P.D. per cell reached 2.4 volts and immediately start the discharging, as well as to stop the discharging when the P.D. per cell reached 1.6 volts and instantly start the charging again, so that the cells were never left discharged.

We used the limits 2.4 and 1.6 volts per cell as the criterions for stopping respectively the charge and discharge since, as already seen, the slope of the charge and of the discharge curves are greatest for about these values of the P.D.

Next, Group No. I was charged with 4.519 amperes and discharged with 9.933 amperes, twice, without intermission, from January 14th to January 19th, inclusive; the P.D. limit for charge being 2.4 volts, and for discharge 1.5.

And while the two sets of tests were being made with Group I, Group II was first charged with 9.104 amperes and discharged with 4.858, twice, without intermission, from January 9th to January 12th. And, lastly, Group II was charged with 4.519 amperes and discharged with 4.858, without intermission, from January 14 to January 19, both days inclusive.

Shortly, then, the tests were:

	Charge.	Discharge.
Group I.	9 ..	10 amperes.
	4½ ..	10 "
Group II	9 ..	5 "
	4½ ..	5 "

The coarse adjustment of the resistance for keeping the current constant was effected by means of resistance coils made of bare German silver wire suitable for standing large currents; the fine adjustment was performed by means of horizontal mercury troughs, through which the current passed, the lengths of the mercury in the wooden troughs through which the current passed being varied by copper bridge-pieces. This mercury trough arrangement forms an extremely convenient resistance for delicate adjustment by hand. To keep the current as constant as possible a dynamo was not used to charge the accumulators under test, but they were charged instead from other accumulators of much greater storage capacity.

The general expressions for the ampere hours and watt hours given out by an accumulator are, of course.

$$\int_o^{t_1} A_1\, dt, \text{ and } \int_o^{t_1} V_1\, A_1\, dt,$$

where A_1 and V_1 are the current in amperes passing through the accumulator, and the P.D. at its terminals at any moment, and t_1 is the time in hours during which the discharge lasts. Consequently, if A_2, V_2 and t_2 have similar meanings for the charge, the complete expressions for the quantity and energy efficiency are, respectively,

$$\int_o^{t_1} A_1\, dt \div \int_o^{t_2} A_2\, dt,$$

and $$\int_o^{t_1} V_1\ A_1\, dt \div \int_o^{t_2} V_2\ A_2\, dt.$$

In our experiments A_1 has a constant value during the discharge, and A_2 a constant value during the charge, so that the expressions for the quantity and energy efficiency reduce themselves to

$\frac{A_1\, t_1}{A_2\, t_2}$, which is very easy to calculate,

and $$A_1 \int_o^{t_1} V_1\, dt \div A_2 \int_o^{t_2} V_2\, dt.$$

To obtain $\int_o^{t_1} V_1\, dt$ a time curve of the values of V_1 is drawn and integrated; similarly, to obtain $\int_o^{t_2} V_2\, dt$ a time curve is drawn for V_2 and integrated; then, multiplying the first integral by the steady value of the discharge current A_1, and the second integral by the steady value of the charge current A_2, we have, respectively, the watt hours given out in the discharge and the watt hours put into the accumulators in the charge.

After drawing a series of time curves for the P. D. in the various experiments already referred to, and integrating them with an Amsler's integrator, we obtained the following results for the successive charges and discharges:

GROUP OF 10 CELLS.—NO. 1.

Discharge at 9.933 Amperes.		Charge at 9.05 Amperes.		Percentage.	
Amp. Hours.	Watt Hours.	Amp. Hours.	Watt Hours.	Quan. Efficiency.	Energy Efficiency.
119	2,280	114	2,485	105	94
105	2,045	102	2,220	103	92
101	1,970	101	2,220	100	87
104	2,030	104	2,270	100	89
Discharge at 9.933 Amperes.		Charge at 4.519 Amperes.			
112.5	2,170	115	2,485	98	87
113	2,190	115	2,485	98	88

GROUP OF 10 CELLS.—NO. 11.

Discharge at 4.858 Amperes.		Charge at 9.104 Amperes.		Percentage.	
Amp. Hours.	Watt Hours.	Amp. Hours.	Watt Hours.	Quan. Efficiency.	Energy Efficiency.
154.5	3,005	138.5	2,910	111.5	103
141.5	2,770	129.7	2,820	109	98
Discharge at 4.858 Amperes.		Charge at 4.519 Amperes.			
143	2,785	141	3,075	102	90.5

Now, not only are quantity efficiencies of 105, 103, 111, 109, etc., per cent. impossible, but energy efficiencies of 94, 92 per cent. are also too high, when accumulators are being charged and discharged at the maximum rate allowed by the manufacturers. Further, it is noticeable that for each set of tests both the quantity and energy efficiencies diminish on the whole as the tests proceed. These cells, like the other cells in the Central Institution laboratories, have been charged at regular times; and as the number of ampere hours taken out of them for ordinary laboratory work varies very much, the intervals between the periodic chargings are so arranged that on the whole the cells are charged up much more than they are discharged.

Hence at the commencement of these tests the cells had a large store of energy in them on which to draw in the discharges, the results of which are given in the preceding table. From this we learn this very important fact—that if accumulators be thoroughly well charged up before being tested, then five days' continuous charging and discharging alternately, with even the maximum currents allowed by the manufacturers, fails to give the normal quantity or energy efficiency.

It will be noticed that both the ampere hours and the watt hours are increased by diminishing the current employed. This is partly due to the fact that if a fixed P.D. limit per cell be employed either in discharging or charging, the cell is discharged until the E.M.F. is slightly lower, and charged until the E.M.F. is slightly higher for a small current than for a larger one.

III.—AUTOMATIC CURRENT REGULATOR.

We think it possible that a neglect of the power that accumulators possess of drawing on a store of energy put into them in former chargings may have led experimenters to conclude that the normal efficiency of certain types of accumulators was greater than was really the case. To ascertain the *working efficiency* of the accumulators we were testing, it was clear that they should have charged and discharged alternately with a definite charging and a definite discharging current continuously for a much longer period than five days. And as this would be a very laborious operation if the current had to be kept constant day and night during this period by hand regulation, we proceeded to construct the automatic current regulating device shown in Fig. 5.

A is a set of five accumulators under test, where *B* is a totally independent set of four used to provide the power for working the current regulator. *C* is a platinoid strip of sufficiently large cross section and surface that no appreciable change of resistance can take place by the largest current—ten amperes—that flows through it in these experiments. *D* is a permanent magnet motor, the rotation of which in either direction turns the brass roller *E F* very slowly in one direction or the other, the pinion and toothed wheel of the motor, combined with the small grooved pulley on the toothed wheel shaft and the much larger grooved pulley on the roller, causing the angular motion of the roller to be about $\frac{1}{100}$ of the angular velocity of the armature of the permanent magnet motor. The brass roller *E F* is electrically divided into two halves by the ebonite disk *G*, and little amalgamated disks at the ends of this roller turn with but little friction in mercury cups, *H, I*. Round each half of the roller are wound four bare platinoid wires of No. 26 gauge, and each about 4½ feet long. Their lower ends are soldered to the brass roller, and their upper ends to the brass bar *J K*, small spiral springs (not shown in the figure) being introduced to keep the wires taut. The rod *J K* is held by a cord which passes over two pulleys, and to the end of which is attached the weight *L*. An electric current entering at *H* follows the path *H, E, J, K, F, I*, the path being longer or shorter, depending on the amount of the platinoid wires wound on the two halves of the brass roller. *M* is a solenoid, being, in fact, the coil of an A. and P. ammeter, on the axis of which a rod, *P Q*, was very delicately poised by its being supported by four very fine wires of No. 40 gauge, and each about one foot long. Two of the wires, *N*, on a plane at right angles to the path, joined together where they were connected with the rod at *Q*, but spread out at the top, and similarly *O* consisted of two wires. Thus,

(*Continued on page 10.*)

TELEGRAPHIC

.... In England there are 16 lines on which the Delany multiplex system of telegraphy is in use.

.... The Santa Fe is taking down its telegraph line and rebuilding it west from Kansas City, Longer poles are being used, and the wires are being strung much higher than formerly.

.... Senator Davis, of Minnesota, was formerly an expert telegraph operator, and was, for a long time, employed in the office at Waukesha, Wis. Senator Davis, it is said, was one of the first four men in the country to read telegraphy by sound.

.... The Anglo-American Telegraph Company has declared in London an interim dividend for the quarter ending June 30, 1890, of 15s. per cent. on the ordinary stock and £1 10s. per cent. on the preferred stock, payable on August 1. These are the same rates as those paid for the corresponding period of last year.

.... The work of putting in electric time service over the Union Pacific Railway Company's lines was begun at Kansas City, Mo., last week, by the Western Union Telegraph Company, under the direction of Robert Mitchell, of New York. The service will extend to Portland, Oregon. Six weeks' time will be occupied in putting in the service. Clocks will be put in at the end of each division.

.... The telegraph line from Cape Town has just been opened as far as Mafeking, in British Bechuanaland. It will now be extended northeast to Tati in Metheleland, with a branch to the capital of Lobengula, the king of that country. Mafeking was in the savage wilderness until some time after Sir Charles Warren, a few years ago, made it the headquarters of his army when he placed that country under British protection. It is now a flourishing town, and has become the leading center of the far interior trade. It has a bank and four hotels, and nearly every trade known in civilized lands has its representatives in the rapidly-growing town.

Steno-Telegraphy.

The system of steno-telegraphy, which we fully described in our issue of the 4th inst., says London *Electrician*, was tried on Thursday, of last week, at the Palais Bourbon, in the presence of M. Floquet and the Secretaries of the Chamber. The wire on which the experiments were carried out had a length of about two miles and a half. M. Cassagnes stated that he had transmitted reports at the rate of 25,000 words an hour from Paris to Brussels; of 18,000 an hour to Lyons, and of 15,000 an hour to Marseilles. By means of his manifold system, M. Cassagnes claims to be able to supply simultaneously, with one instrument, all the papers of Paris with Parliamentary reports.

A Large Engine.

The largest engine in use in Rhode Island is now being set up at the station of the Narragansett Electric Lighting Company, in Providence. It is known as the Reynolds-Corliss engine, and is a triple expansion condensing machine of 1,500 horsepower. The fly wheel alone weighs 90,900 pounds, and the whole engine weighs nearly 150 tons. The engine will be in operation by September 1, and the work of concentrating the business of the company in the new Elm street plant will then begin. The new buildings of the company cover a space of over 30,000 square feet. The belt of the engine is one of the largest in the country, being three ply and over 72 inches in width. A duplicate engine is contemplated by the company.

* * An electric railroad, 15 miles long, is to be built at Albuquerque, N. Mex., by a Philadelphia company that has $75,000 capital.

* * An electric railway on the overhead system is in process of construction between Seattle and Tacoma, Washington. When finished the road will be 42 miles long.

* * It is now proposed to continue the Seneca, N. Y., Railway on through Falls street in Seneca Falls, and from that point by the most available route to Cayuga Lake.

* * A projected line of electric railway for West Chester, Pa., contemplates a connection with the Wilmington and Northern Railroad at Lenape Station, four miles distant.

* * Dwight F. Cameron and Lester H. Eames, the recent purchasers of the South Chicago Street Railway Company, are about to construct a six-miles-long electrical street railway.

* * The electric railway at Reading, Pa., was opened last week. The first car was in charge of Mr. Stadelman, chief engineer of Equitable Electrical Construction Company, of Philadelphia. The trip was highly successful and satisfactory to the Readingites.

* * The village of South Weymouth, Mass., is to be connected with Rockland, Abington, Hanover and Whitman, by a street railway. A company is to be formed, to be known as the Hatherly Street Railway, with a capital stock of $100,000. The project is looked upon with favor by the residents of the town.

* * The Fort Myers *Press* says that the International Ocean Telegraph Company now has two cables in perfect order between Punta Rassa, Florida, and Havana, which is the first time since the line has been established; and the company are now at work stringing an extra wire between Jacksonville and Punta Rassa to enable them to work the duplex system from Jacksonville to Havana, using one wire solely for that purpose, and the other for way offices under the old system.

* * An extract from a letter received from Edinburgh, Scotland, states that the electrical exposition, which was opened some time since by the Duke of Edinburgh, was a grand success, and one of the attractions was a circular track on the Riley system of elevated railroads, built on posts 30 feet high, and cars run by electricity. Elevated electric railroads are looked upon with so much favor that the project for a tunnel has been abandoned, and there is no doubt that elevated railroads will be built in Edinburgh in the near future.

* * The Fence Factory of Garner Wright, No. 711 East Adams street, started up last week. This is the first stationary industry in the city to be run on the new electric power circuit of the electric light company. A two horse-power motor, of Peoria make, runs a fence machine which will turn out from 160 to 200 rods of lath fence per day. Considerable interest was manifested, quite a crowd congregating to watch the first application of electric power to such mechanical purposes in Springfield.—*Springfield, Ill., Journal.*

* * The State Railroad Commission last week approved a change of motive power by the Coney Island and Brooklyn Railroad Company from horses to the overhead single trolley electric system, upon that portion of its railroad upon Seabreeze avenue, from East Fifth street to West Fifth street, with the following conditions, however, which are made part of this approval: First—The rate of speed shall not exceed that to be determined upon by the Commissioners of Highways of the Town of Gravesend. Second—No car shall be run with less than two men to operate it.

The Chamberlain Battery Rack.

The United Electric Traction Company have in operation in their station, 85th street and Madison avenue, New York City, a very interesting method of changing charged for discharged secondary batteries used in their storage battery street railway system. The perfection attained in the operation of substitution is due to a well-known electrician of this city, Mr. J. C. Chamberlain.

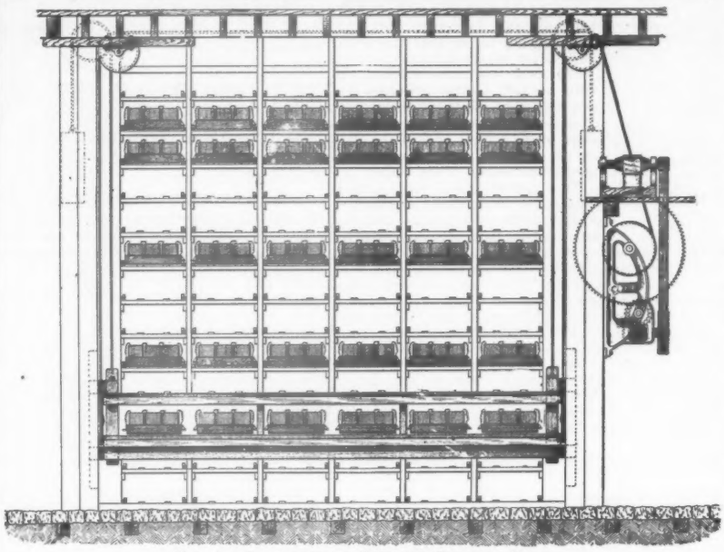


FIG. 1.—CHAMBERLAIN STORAGE BATTERY RACK.

The rapidity and ease with which the batteries are shifted is astonishing. A car having discharged batteries is run into the station, and into a sort of stall between two racks of superimposed shelves; there is a sort of sliding noise, a movement of the elevator platforms on each side of the car, and the car is rapidly run out, leaving the station within three minutes of the entry. In that time a complete set of batteries, having a charge sufficient to carry the car on its journey to the Post Office and return (11 miles), has been substituted for the exhausted batteries, and the latter have been automatically connected into the charging circuit on the racks, and are again being charged.

The general construction of the racks and hoisting mechanism is shown in the accompanying illustrations, Fig. 1 being a side view of a rack and hoisting mechanism, and Fig. 2, a vertical, transverse section, with car in position. The racks have a number of shelves superimposed, as shown, and are adapted to receive the drawers of batteries. When the batteries are in place on the shelves they automatically make connections with the charging dynamos, which are not shown in these illustrations. An immense number of cells may be packed within the limited floor-room taken up by these racks, the latter being placed far enough apart to receive between them a street car, and usually the hoists. The floor space occupied is but 24 by 7 feet on each side of the car, and there are contained within this space cells enough to do the work of from 130 to 150 horses, which may be fairly said to represent the stall room these horses would require, namely, about 6,000 square feet. The hoists are usually arranged between the racks and the car. The hoists on the opposite sides of the car are independently operated by electric motors; these motors, however, are only used in elevating the platforms.

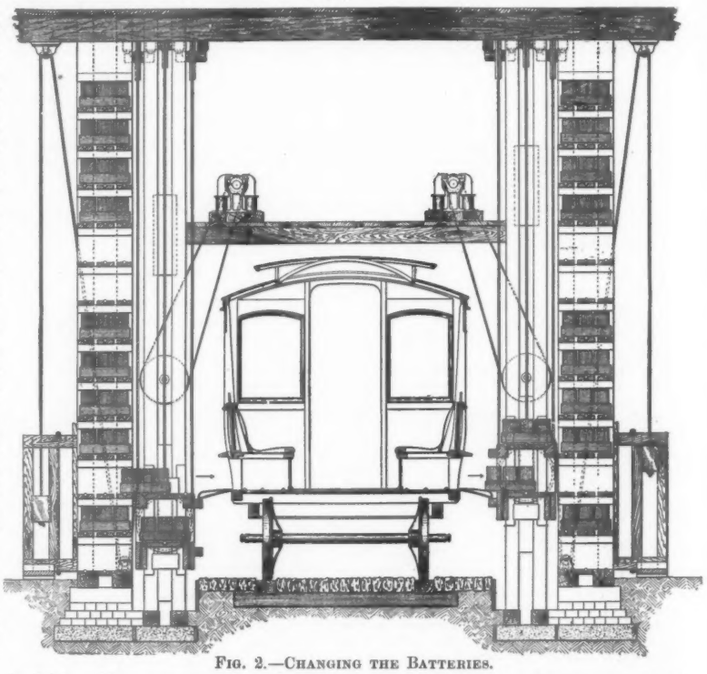


FIG. 2.—CHANGING THE BATTERIES.

For lowering them to any place desired, opposite the racks or the car, an ingenious friction brake in the elevator winch is used. By throwing off the motors, and allowing the hoists to drop under the control of the friction brakes, a considerable saving of time is effected. A charged set of batteries is loaded on the upper platform of the hoists, in readiness for an incoming car. When the car is run into the stall, the cove panels thereof are quickly dropped to form a bridge to the lower platform of each hoist, which has been brought into position, as shown at the right of Fig. 2. The discharged batteries are pulled out from the car, over this bridge, on to the lower platform, the hoist then dropped to the position as shown at the left in Fig. 2, and the charged batteries are shoved into place on the car. The panels are then closed up automatically, the car moves out, the hoists are raised, the discharged batteries on the lower shelves are run on to vacant shelves at the same height on the two racks, and the top platform is re-loaded with charged batteries for the next car. The shifting can be done rapidly by means of one man on each side standing on the platform which is shown, and which is connected by ropes with the hoist on each side, so as to rise and fall with the latter, and so be always in position opposite the hoist at whatever part of the rack it may be.

The system has been patented by Mr. Chamberlain in the United States and foreign countries; the foundation patent having been issued on May 6, 1890. A patent covering certain improvements is shown in the current issue of the Official Gazette. The details of the construction have been well worked out. Fig. 3 illustrates the form of binder, also patented by Mr. Chamberlain, which is used for connecting adjacent ends of the two cells of the batteries. It is important that single cells shall be coupled rapidly and removed without disturbing the remaining cells in the same drawer; and, also, that good electrical contact shall be maintained between the electrode terminals, which are connected by the binder. Mr. R. N. Chamberlain is to be credited, in part, with the solving of this problem. Advantage is taken of the binding action of a hard rubber screw in a socket of the same material.

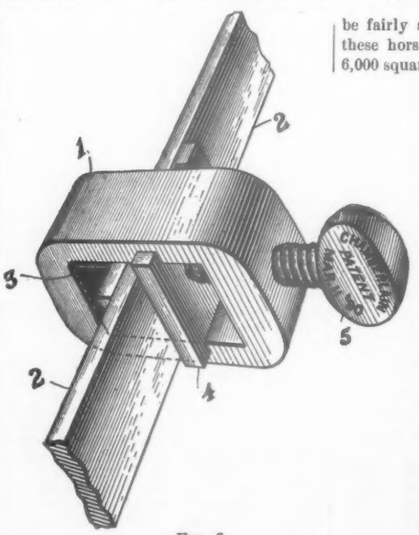


FIG. 3.

Referring to the figure, 1 is a loop of hard rubber, adapted to receive two ends of the electrodes of adjacent batteries, which are represented at 2. A rubber cushion, 3, is arranged at one end of the loop, and a hard rubber washer 4, and hard rubber screw 5, at the other end. By turning the thumb screw the battery terminals are pressed tightly together between the hard rubber washer and soft rubber cushion. The rubber cushion insures the maintenance of such pressure as to prevent any turning of the thumb screw, and loosening of the electrical connection.

Regarding an Electric Light Patent.

Judge Lacombe, of the United States Circuit Court, made an order last week appointing Henry C. Monk, of Ottawa, Canada, a commissioner to examine Wm. D. McDougal and Desire Gironard, concerning an electric patent secured in Canada, and which is the subject of a lawsuit now pending, brought by the Edison Electric Light Company. The evidence sought for by this appointment is as to whether or not the patent secured by Edison in Canada, on November 17, 1879, would lapse by a patent on the same invention being secured subsequently in Sweden.

Westinghouse Declares a Dividend.

A special meeting of the Westinghouse Electric Company was held on July 26, in the offices of the company, at Pittsburgh, to consider the advisability of paying a dividend. It was decided to pay a dividend of four per cent. on the capital stock, payable on the first of September. An addition to the board of directors was made in the person of N. W. Bumstead, of Boston. This is the first time that a non-resident of Pittsburgh has been elected to the Board. The other directors included George Westinghouse, Jr., president; Robert Pitcairn, George Herbert, John R. McGinley, H. C. Jackson, S. F. Kobbe and H. C. Gordon. The following resolutions were passed:

Resolved, That, from the net earnings of the company, a semi-annual dividend of four per cent. upon the capital stock be, and the same is, hereby declared payable September 1, 1890, in scrip of the company to the stockholders of record July 31, 1890; the said scrip to be payable September 1, 1900; to be redeemable after 60 days' notice on the first days of March and September in any year prior to the date of maturity, at the option of the company; or to be convertible into the stock of the company at par at the option of the holder; certificates to bear interest at the rate of 6 per cent. per annum, payable semi-annually on the first days of March and September to holders of record; certificates to be convertible into the stock of the company only when presented in sums of $50, or in multiples thereof; and to be transferable on the books of the company only in person or by attorney.

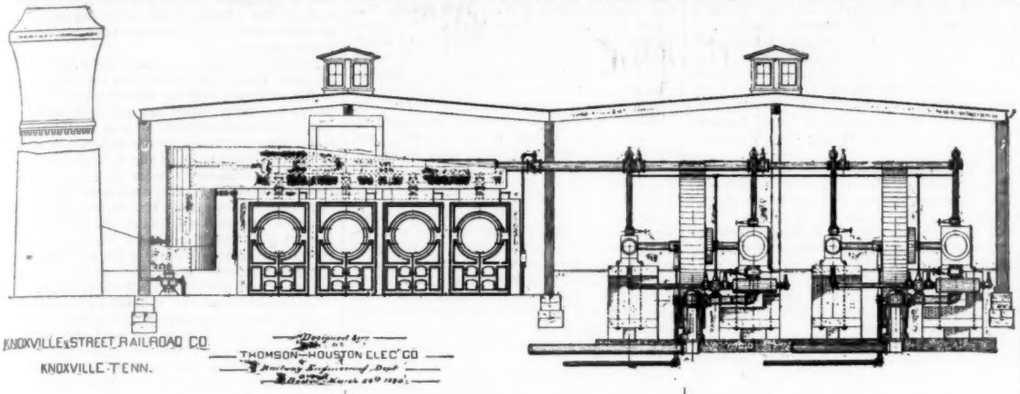
Resolved, That the President and Treasurer of the company be and they are hereby authorized to prepare the proper form of the scrip herein provided for, and to execute and deliver the same; that notice hereof be sent to each stockholder, and that the transfer books be closed July 31 and August 1.

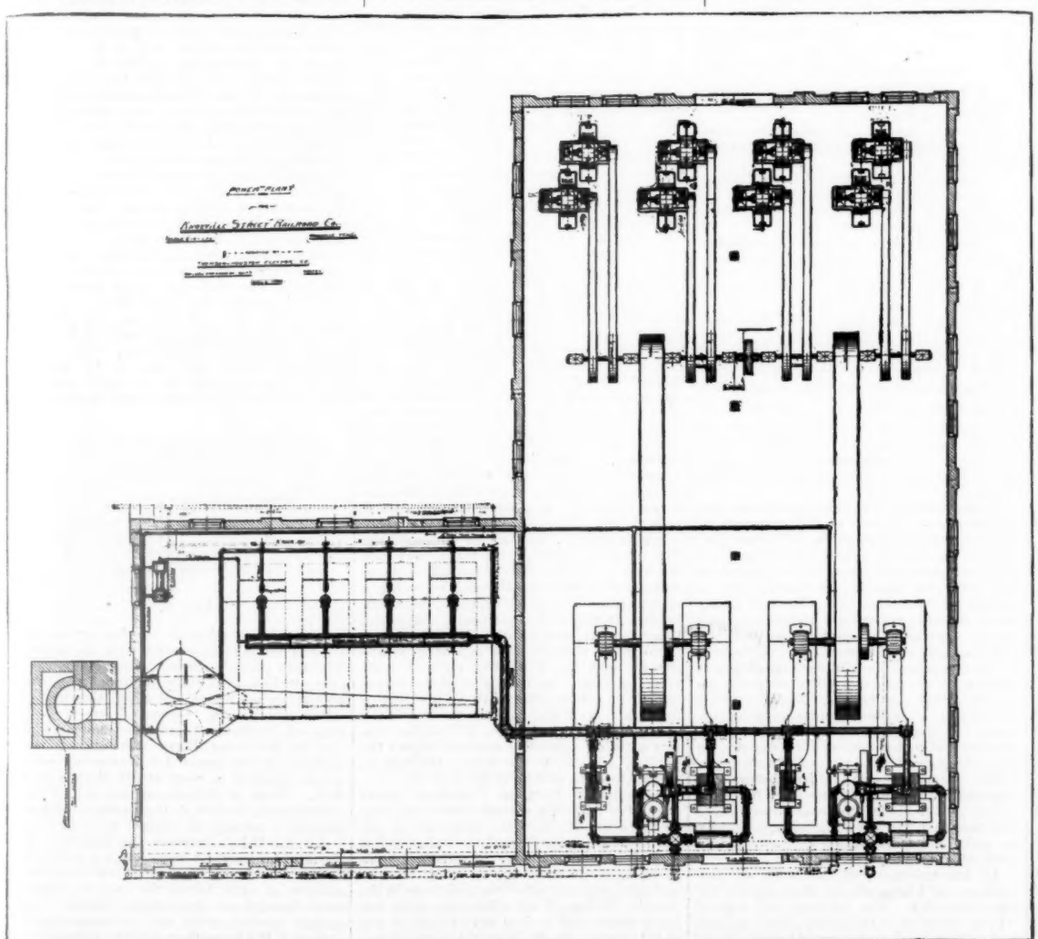
Resolved, "In view of the suggestion made by many stockholders that the time is too limited within which the privilege of subscription to the new stock may be exercised; that the right of stockholders of record July 8 to subscribe for one-half of a share for each share of stock held by them, respectively, on that date be and the same is hereby extended from August 1 to August 30; and that the time for payments to be made for the stock be extended to the 30th days of August, September, October and November, and that notice of this extension of time be mailed to each stockholder."

In the circular issued to the stockholders under date of June 4, the management stated: "In view of the large increase in the company's business, and the need for more capital, the company deem it expedient to defer action with reference to a dividend until after the stockholders' meeting to be held July 8;" and the action yesterday was in according with this understanding. It is understood that the form of dividend decided upon is the result of a conference between the officials of the company and large stockholders in the East, who have a very full appreciation of the magnitude of the electric business and the necessity for using, for the present, all of the earnings of the company in the extension of the business. They, however, felt that they were entitled to a continuation of the dividends, which they recommended should be in the form of scrip. On the strength of this dividend, the stock immediately rose from 36½ to 41½.

Lighthouse Arc Lamps.

Alluding to the loss of light from electric lamps in a fog as compared with the yellow gas light, it is suggested that the loss is owing to the blueness of the fog or mist; the electric light merely intensifying the blueness, while the gas still pierces the gloom. If the blue electric light were changed from blue to yellow before leaving the lighthouse, or, better, make the electric light one to be varied in color at will, or according to the state of the atmosphere, then, even though several thousands of candle-power were absorbed, the light would be seen at a much greater distance even than the gas in a foggy night. It is suggested that the inauguration of a series of tests and experiments with different lights, surrounded by different colored transparent films, and under the various conditions of the atmosphere, should lead to useful results. We think the attention of lighthouse authorities ought to be called to the greatly increased lighting power, and this of a yellower character, experimentally obtained by the introduction of hydrocarbon vapor in the arc by the use of the Saunderson arc lamp carbons recently described, and we should be glad to hear if any tests have been made with these carbons for lighthouse purposes, and the results.—*London Electrical Engineer.*





ELECTRIC LIGHT NEWS

—— The Jenney Electric Company will light the new Court House at Evansville, Ind., with 875 incandescent lamps.

—— The new Westinghouse alternating current arc light system is becoming daily more popular. In Moline, Ill., and at the Jarecki Manufacturing Company, Erie, Pa., that system is being installed now to the extent of 25 lights in each place.

—— The Monongahela City Electric Company, an organization lately established, has just concluded negotiations with the Westinghouse Electric Manufacturing Company for alternating current incandescent apparatus of 750 lights capacity.

—— Leck & McLeod have the contract to build the electric tower for the Edison exhibit at the Minneapolis Exposition. This is to be octagonal in shape and 70 feet high. The New York tower was but 30 feet high. There will be 7,500 incandescent lights arranged upon it.

—— The Narragansett Electric Lighting Company, of Providence, R. I., is erecting an immense chimney at its new station. The stack has already been raised 164 feet, and will be continued until it reaches a height of 250 feet, when it will be the tallest chimney in Rhode Island. The work of construction was begun last year and will probably be completed in about four weeks. Over 1,500,000 bricks will be used before the cap is set in place.

Power Station of the Knoxville Street Railroad Company.

A recent installation made by the Thomson-Houston Electric Company is shown in the accompanying illustrations of the power station built for the Knoxville Street Railroad Company, Knoxville, Tenn. The drawings are the plan and section of the elevation from which the construction of the station and the disposition of the apparatus can be readily seen. The building is one story, brick, and divided into boiler and engine and dynamo rooms. The steam plant consists of four steel tubular boilers, built for high pressure, to be operated from 115 to 125 pounds pressure, with furnaces designed for burning a low grade of slack coal. Economizers are also provided for utilizing the waste gases in bringing the feed water up to the boiling point before it is pumped into the boilers. Four ways of feeding the boilers are made use of, and so arranged that, in case of accident to any one of them, the operation of the steam apparatus would in no way be impaired.

The engines are of the cross compound condensing Corliss type, and so arranged that each pair, which is considered as one engine, can be operated as a twin engine, and in case of accident, either side can be run alone. Each side can also be worked high or low pressure, so that provision is made for operating the plant, even though half of the engine is undergoing repairs. This is the first plant of its kind in the world which has been erected for electric railway purposes, and very satisfactory results are anticipated from it. Each engine will carry its full load, under the varying conditions of railway work, on an evaporation of 18 lbs. of water per horse-power per hour.

The engines are of extra large proportions throughout, so as to withstand the severe strain incidental to railway work.

The electric apparatus comprises eight Thomson-Houston railway generators and the usual appliances for their operation. Each generator, as is the same with the engines, is arranged so as to be thrown in or out of action without interfering in the least with the operation of the remainder of the plant. The engines, boilers and piping were furnished by C. & G. Cooper, of Mt. Vernon, O., and the counter-shafting by the Holyoke Machine Company, of Worcester, Mass. The plant is rapidly nearing completion, and will be in operation some time this month. The installation was designed by Mr. L. H. McIntire, of the railway engineering department of the Thomson-Houston Electric Company. The electric railway for which this plant is designed is 3.40 miles in length, and will operate five motor cars.

ELECTRIC CLUBS.

New York Electric Club.

Mr. Eugene Phillips, one of the oldest members of the Club, not content, apparently, with his eminent success in the electrical field, is also willing to do some work in financial circles, and was recently elected director of the City National Bank, of Providence.

Mr. J. H. Reid, of Chicago, was a Club visitor last week, and met many of his Eastern friends.

Owing to the Absence of the president in Europe, the committees of the Club have not yet been appointed, the former committees holding over. President Madden having returned, the new committees will probably be selected at the August meeting of the Board, which occurs on the 14th.

The New York Club will be the headquarters of the parties going to the Cape May Electric Light Convention. A special party goes down on the 16th, under the supervision of Mr. John A. Seely.

Commodore Chas. A. Cheever, one of the Club's popular members, is off on the cruise of the New York Yacht Club. His yacht, the "Crusader," is one of the handsomest and best kept in the fleet, and is a beautiful going schooner yacht, about 100 feet in length. Although not entered for racing this season, she was fourth to arrive on the trip from New London to Newport out of over 50 yachts. The Commodore will be absent four weeks.

Col. Henry G. Davis, the first president of the Electric Club, returned from London last week on the "Umbria," and will spend a few weeks in New York, making his headquarters with his son, Mr. Carl Davis, the electrical engineer, at 120 Broadway.

Mr. Henry Metzger, the eminent telephone man of Pittsburgh, visited his friends of the Electric Club last week.

California Electrical Society.

Professor Keith took the chair at the meeting of the California Electrical Society held on July 21, the first meeting in the new quarters in the Murphy building. After a few remarks on the glowing prospects of the society, by Professor Keith, the executive committee reported progress in the matter of furnishing the new quarters. W. L. Brown donated a volume on magnetism printed in Latin in 1629. For this he was elected a member for one year free of dues. W. C. Quimby gave some of his experiences with lightning rods in Missouri in 1859. The society intends to at once establish a laboratory and library for the use of the members.

Nashville Electric Club.

A Meeting was held at the office of Dr. T. A. Atchison, on July 23d, for the purpose of organizing a Club of gentlemen interested in a business way in electricity. The following were present: A. H. Stewart, Western Union Telegraph Company; E. G. Connette, superintendent United Electric Railway Company; L. E. Marple, electrician United Electric Railway Company; A. Dahlgren, treasurer, W. A. Burkholder, superintendent, T. A. Atchison, president, Capital Electric Company; Robt. L. Morris, attorney; J. W. Braid, electrician, J. A. Targley, chief engineer, United Electric Railway Company; Fred. W. Fairfield, city electrician; T. W. Johnson, late electrician Telephone Company; J. W. Rust, Western Union Telegraph Company; Dan. W. Baird. Mr. A. H. Stewart was called to the chair and D. W. Baird made temporary secretary. The objects of the meeting were explained, and, after some discussion, a committee, composed of A. H. Stewart, Fred. W. Fairfield and J. W. Rust, was appointed to formulate a plan for permanent organization. The following committee on constitution and by-laws was appointed: A. Dahlgren, E. G. Connette and L. W. Johnson. Another meeting will be held at Dr. Atchison's office during the week.

According to the *American Geologist*, the largest gold mine is in Alaska. It is lighted throughout by electricity, and is worked day and night. An offer of $16,000,000 for this mine has been refused.

The Cape May Convention.

TOPICS TO BE DISCUSSED AND REPORTS TO BE CONSIDERED, BEGINNING AUGUST 19, 1890.

The Committee on Papers have selected the following topics, and have invited the persons named to prepare a paper or open discussion on the subject assigned him:

1. Electrical Industries and the World's Columbian Fair; J. P. Barrett, Chicago.
2. Electric Light as Supplied to Steam Railroads; W. H. Markland, Altoona, Pa.
3. Standards of Economy in the Generation of Power and Steam Under Best Conditions; Editor of *Power and Steam*, N. Y.
4. Triple Expansion High Speed Engines for Central Station Work; —— Williams, Beloit, Wis.
5. The Model Boiler Room and the Duties of a Fireman; Jarvis B. Edson, New York.
6. Ferranti Station at London, England; Caryl Haskings, Lynn, Mass.
7. The Proper Care and Management of Alternating Currents; T. Carpenter Smith, Philadelphia.
8. Distribution of Energy by Alternating Currents and Transformers, and the Proper Method of Proportioning Conductors; A. H. Rohrer, Lynn, Mass.
9. The Proper Basis for Determining Electric Motor Rates; H. L. Lufkin, N. Y.
10. Actual Cost of Furnishing Arc Lighting (1,200 c.p., and 2,000 c.p. Lamps) under the Best Possible Conditions; J. C. Ayer, St. Louis, Mo.
11. Municipal Ownership of Electric Lighting Plants; M. J. Francisco, Rutland, Vt.
12. Accidents in Electric Lighting Stations and Plants; Prof. Charles R. Cross, Boston, Mass.
13. Care and Labor in Electric Light Stations and its Value; A. J. De Camp, Philadelphia, Pa.
14. How can the National Electric Light Association Best Serve the Interests of Central Station Companies? C. R. Huntley, Buffalo, N. Y.

REPORTS TO BE CONSIDERED.

1. Committee on National Insurance Rules; George Cutter, chairman.
2. Committee on Electrical Data; A. J. De Camp, chairman.
3. Committee on Copper Tariff; Charles A. Brown, chairman.
4. Committee on Underground Currents and Conductors; Joseph E. Lockwood, chairman.
5. Committee on Revision of Constitution; M. J. Francisco, chairman.
6. National Committee on Legislation; Allen R. Foote, chairman.
7. Committee on Relations between Manufacturing and Central Station Companies; Marsden J. Perry, chairman.
8. Executive Committee; C. R. Huntley, chairman.
9. Finance Committee; John A. Seely, chairman.
10. Secretary and Treasurer's Report; Allen R. Foote.

At each session of the Convention, a call will be made for the proposal of questions to be discussed at a subsequent session, and for the introduction of resolutions to be considered at a subsequent session when reported by the Committee on Resolutions for action.

Members desiring to take part in the discussion of any subject, stated or proposed, who send their names to the secretary previous to the time appointed for its consideration, will be called upon by the president and be given time before the subject is opened to the Convention. By this means every member can secure recognition and time to express his views fully on any subject that may come before the Convention. It is not expected that those who read papers or open the discussions will monopolize all the time that can be given to, or exhaust the subject. The best results from discussions can be obtained only when every member who has an idea to explain, a suggestion to offer, or a bit of experience to relate, regarding any subject before the Convention, will avail himself of the regulation, stated above, to secure recognition and time that will give him an opportunity to make his contribution to the common stock of information.

An announcement of the order of proceedings will be made for each day on the preceding day. The subjects and reports will be taken up in the order there named, and will be held under consideration until finished. Each afternoon session will be prolonged until the calendar for the day has been cleared.

The last session will be an executive session, to be attended by active members only. The business to be brought before the session will be:

1. Secretary and Treasurer's Report.
2. Report of Finance Committee.
3. Report of Executive Committee.
4. Action on Report of Committee on Revision of Constitution.
5. Election of Executive Committee.
6. Selection of next place of meeting.

THE SECONDARY BATTERY.

(*Continued from page 7.*)

while the rod $P\ Q$ had great freedom of motion along its axis, it could not wobble sideways. This rod consisted of two pieces of brass at its ends, but the middle shaded portion was the well-annealed soft iron tubular core of the ammeter. A current passing round the coil M sucked in the core more or less against the pull of the antagonistic spiral spring $P\ P$. This spring was made of platinoid wire of No. 26 gauge, wound round a ¾-inch mandril, and when pulled out in position it had about 30 turns to the foot, and was over four feet in length. One end of the spring was attached to the rod at P, while the other, P, was fastened to a fine thread, which could be wound up more or less round a small roller, and the tension of the spring very delicately adjusted.

At first the elasticity of this spring was not perfectly constant, but after about one month's use the pull it exerted when stretched to a given length became wonderfully definite, and the core $P\ Q$ could be adjusted so that for a current of exactly nine amperes flowing round the solenoid M the projection at P remained midway between the contacts R and S without touching either. But on the current flowing round the solenoid M becoming very slightly greater, or very slightly less than nine amperes, the platinized projection of the rod at P made contact with either the platinized piece R or S. The permanency that the spring eventually attained was so great that even when the apparatus had not been in use for two or three weeks, one had only to close the circuits to start the regulator, and no fresh adjustment whatever of this spring was necessary to ensure that the current would be kept absolutely constant at nine amperes. This spring has, however, now gone the way of most bare fine platinoid wire, of breaking up into pieces.

When the cells A under test were being charged by means of a set of accumulators not shown on the figure, but attached to the leads T and U, three copper bridge-pieces were put in to connect the mercury cups 4 to 5, 2 to 6, and 1 to 3, respectively; whereas when the test cells were being discharged, two copper bridge-pieces connected the mercury cups 2 to 3 and 5 to 6. The current passed, of course, one way through the cells A in charging and the other way in discharging; but in both cases a positive current flowed, as indicated by the arrows, through the thick lead V, the platinized strip C, through H, E, J, K, F, I, through the thick lead W, the thick lead Y, the solenoid M, and the thick lead Z. As already explained, if the currents through this circuit exceeded in the very least nine amperes, the core $P\ Q$ was sucked into the solenoid M until P made contact with R; whereas, if the current fell in the least below nine amperes, $P\ Q$ was pulled back by the spring $P\ P$ until P made contact with S. In the former case a small auxiliary current from the accumulators B follows the course a, b, c, d, through the spirals e—several in number, so as to carry the current, but of extremely fine wire, as to oppose practically no resistance to the free motion of $P\ Q$—then from P to R, through f, the electro magnet g, and through h, back to the other pole of the battery B. If, instead, P be in contact with S, then the current from the auxiliary accumulators B passes from P to S through the relay electro-magnet i, instead of through the relay electro-magnet g. In the former case the spring tongue k is attracted so as to make contact with M (M being in reality a mercury cup into which dipped a platinum point with which k was tipped), and in the latter case the spring tongue l is attracted so as to make contact with m. If k makes contact with m, a positive current, commencing from the middle of the accumulators B follows the path n, the motor, through o, m, k, and back to the end of the accumulators p; whereas, if l makes contact with m, a positive current follows the path q, a, l, m, o, the motor, through n, and back to the middle of the cells B.

Accordingly, then, as P makes contact with R or with S, a current is sent one way or the other through the armature of the permanent magnet D, and the roller $E\ F$ is turned around one way or the other so as to unwind, or wind up, more of the wire and automatically alter the resistance in the circuit. Although the whole apparatus was home made, and looked very rough, it was able to automatically keep the current constant to one part in 600 for days at a time.

As the charge was effected with nine amperes and the discharge with ten, a shunt, r, exactly nine times the resistance of M, was connected across M during the discharge, and as the automatic regulator kept the current through M constant at nine amperes, it kept the current through the circuit constant at ten when the shunt r was attached to M.

The necessity of using the relay electro-magnets g and i arose from the fact that the only suitable permanent magnet motor which was at our disposal was a laboratory hand magneto Gramme machine which required a current of about one ampere to work it, and to obtain great sensibility the contacts between P and R or P and S had to be too slight to carry such a current.

It was very interesting to watch the regulator, since the armature of the motor was almost always in motion, now making half a turn one way, now one turn the other. It may be mentioned that one turn of the motor armature shortened or lengthened each of the platinoid wires by about $\frac{1}{10}$ of an inch—that is, by less than the $\frac{1}{3000}$ of its whole length.

At first all sorts of plans were tried for keeping clean the surface of the mercury in the mercury cup m; but alcohol floated on the mercury failed because it dried up, water was electrolyzed, oil was carbonized, and a long conducting point adhered to each of the platinum points l and k, and the auxiliary accumulators B were short-circuited. In despair, we left the surface of the mercury completely exposed to the air, and were surprised to find that that answered perfectly; a thickish layer of mercury and mercurous oxide formed on the top, but the platinum wires easily forced their way through, and always made good contact.

To avoid, however, all risk of accidents, cut-outs were introduced into various parts of the circuit; and to prevent the motor overwinding the platinoid resistance wires on the roller $E\ F$ and breaking them, should the current in the main circuit accidentally become much too small, as well as to prevent the motor unwinding the wires too far off the roller, should the current become much too large, safety keys (not shown in the figure) were provided. If the rod $J\ K$ were drawn down dangerously low, or allowed to go up too far, it touched one or other of the safety keys and broke the electrical circuits.

IV.—AUTOMATIC INTERRUPTOR FOR BREAKING THE CHARGING AND DISCHARGING CIRCUITS.

As it was extremely important that both the charging and discharging circuits should be broken at the exact moment when the P. D. in its rapid variation passed through certain specific values, and as in a long course of experiments, lasting for several months, it was quite possible that occasionally no one of the observers would be present at the exact moment, we arranged an interruptor to break the circuit automatically when the P. D. in charging reached 2.4 volts per cell, or 1.6 volts per cell in discharging. The automatic interruptor was arranged thus: s is a D'Arsonval galvanometer, the coil of which, wound with platinoid wire of 154 ohms resistance, is joined in series with a resistance box, t, as a shunt to the accumulators A under test. Electric connection was made with the bottom of the coil by means of a fine spiral spring too thin to introduce any controlling moment, while above the coil was suspended by a phosphor-bronze strip $\frac{1}{1000}$ inch thick, $\frac{1}{100}$ broad, and $1\frac{3}{4}$ inches long. This strip has seven twists put into it by means of a head moving in a tight collar, the coil being prevented from turning by

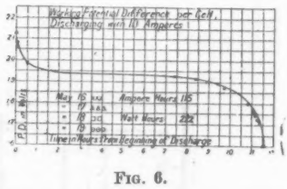

Volts Electrical Difference per Cell.
Discharging with 10 Amperes
Ampere Hours 115
Watt Hours 221
Time in Hours from Beginning of Discharge

FIG. 6.

a pointer, u, attached to the framework of the coil coming into contact with the stop v. The thin phosphor-bronze strip being very thin, it had very little torsional rigidity, and being set up as described, this instrument acted as a "set-up voltmeter"—a type of instrument proposed some years ago by Professor Perry and one of the authors of the paper for measuring with great accuracy a very small change in a P.D. With a definite adjustment of the resistance in the box t, the platinum-tipped pointer u remains in contact with the stop v for all P.D.'s between the terminals of the accumulators A less than 2.4 volts per cell. When the P.D. reaches this value the pointer at once leaves the stop v, moves over through an appreciable distance, and makes contact with the platinum-tipped stop w. With another definite adjustment of the resistance in the box t, the pointer u remains in contact with w for all P.D.'s between the terminals of the accumulators A greater than 1.6 volts per cell, but the moment this value is reached the pointer moves away from w and makes contact with the platinum-tipped contact stop v.

When charging, a copper bridge-piece connects the mercury cups 7 and 8, and when, on the P.D. at the terminals of the accumulators A reaching 2.4 volts per cell, the pointer u passes over and makes contact with w, an instantaneous small current is sent by the accumulators A through the

electro-magnet x, which, attracting the armature y downwards, tilts the spindle z, and thereby lifts X and the other two contact forks out of the three sets of mercury cups, thus breaking *all* the circuits. The tilting of the spindle z also brings a camel's-hair brush into contact with the balance of a watch, and stops it at the moment the charging is completed.*

In discharging the cells A, mercury cup 7 is connected to 9 instead of to 8. During the discharge the pointer u rests against w, and on the terminal P.D. of the cells falling to 1.6 volts per cell, the pointer moves over, comes into contact with v, and an instantaneous current passes round the electro-magnet, breaks all the circuits, and stops the watch. The course of this instantaneous current at the end of the charge and discharge is indicated by the arrows numbered, consecutively, 10, 11, 12, 13, 14, 15, 16 and 17.

To prevent any sluggishness in the action of this interruptor, from a possible sticking of the pointer u against the contact stops v or w, the pedestal supporting the set-up galvanometer s was kept in a constant state of slight vibration by the going of an American clock works that were placed on this pedestal.

V.—AMMETER AND VOLTMETER.

There remain only to be described the ammeter by means of which the current passing through the accumulators could be measured from time to time in order to see whether the automatic regulator was doing its duty, and the voltmeter for frequently measuring the P.D. at the terminals of the accumulators A under test. As the current had only to be very occasionally measured, one D'Arsonval galvanometer, β, was employed for both purposes. Its coil was wound with platinoid wire of 52 ohms resistance, and suspended in the way that has been already described,† which enables the defection from one end of the scale to the other to be absolutely proportional to the current. The top suspension was a phosphor-bronze strip $\frac{1}{1000}$ inch thick, $\frac{1}{100}$ wide, and about $1\frac{3}{4}$ inches long; while electric contact was maintained with the bottom of the coil by means of an extremely fine A. and P. spring, offering no appreciable torsional rigidity. The permanent magnets employed belonged to an old magneto machine, and into the cylindrical space between their poles, in which the Siemens armature formerly turned, was put a coil made of the right shape to suit the curved ends of the magnets without it being necessary to employ any soft iron pole pieces. Experiment showed that the deflection right across a scale two feet nine inches long, the zero for no current being at one extreme end, was rigorously proportional to the current—a result which, as has been already pointed out, is very far from being obtained

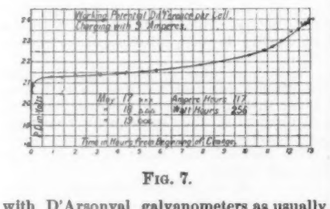


FIG. 7.

with D'Arsonval galvanometers as usually constructed.

When it was desired to measure the current passing through the accumulators A, a rocking switch was turned so as to connect mercury cup 18 to 20 and 19 to 21; whereas, when it was the P.D. at the terminals of the accumulators that was to be measured, the rocking switch was turned so as to connect mercury cup 20 to 23 and 21 to 22. In the former case, with a resistance of 264 ohms on the resistance box γ, a current of ten amperes passing through the cells and platinoid strip C produced a deflection of 500 scale divisions, or 50 divisions per ampere; while, with a resistance of 71,570 ohms in the resistance box δ, a P.D. of ten volts at the terminals of the five accumulators A under test produced the same deflection; so that 50 divisions corresponded then with one volt.

VI.—RESULTS OBTAINED WITH AUTOMATIC APPARATUS.

Many preliminary experiments having been made with the automatic apparatus, we succeeded in making it work quite satisfactorily by the beginning of May, 1889, and it was adjusted to charge five accumulators A (Fig. 5), with a steady current of 9 amperes until the P. D. reached 2.4 volts per cell, and to discharge them with a steady current of 10 amperes until the P. D. fell to 1.6 volts per cell. After 12 days and nights had been spent in continuous charging and discharging, the cells reached a normal state, the time rise of P. D. in charging and the time fall in discharging being at length repeated over and over again, so that when the time curves were drawn for the successive charges they exactly coincided, and so for the discharge curves. The areas of these curves—reckoned, of course, from the zero of P. D., which is much below the figure as here shown—may thus be said to give the "working watt hours" for charge and for discharge when the charge and discharge are effected between limits of 1.6 and 2.4 volts per cell. Fig. 6 shows the discharge curves obtained on May 16th, 17th, 18th and 19th, the points for each of the discharges being indicated by points differently marked, as stated on the figure; and Fig. 7 shows the intermediate charge curves obtained on May 17th, 18th and 19th. Integrating these curves, we find

Discharge.		Charge.		Percentage Working Efficiency.	
Amp. Hours.	Watt Hours per cell	Amp. Hours.	Watt Hours. per cell	Quan.	Energy.
115	221.8	117	256.2	98.3	86.5

Soon after this very concordant set of results was obtained, the time of charging, which had remained steadily at 13 hours from the commencement of May, began to increase to 15½ hours, while the time of discharge only increased half an hour—that is, only about 12 hours. At first we thought that we had been trying to charge the cells too much, so we stopped the charging when the P.D. per cell rose to 2.35 volts; but the time of charging still continued to increase, until at last it rose to 24 hours, the time of discharge still remaining about 12 hours.

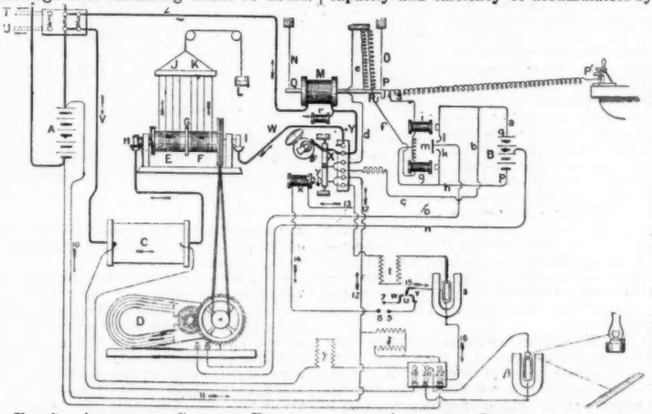


FIG. 5.—AUTOMATIC CURRENT REGULATOR AND AUTOMATIC INTERRUPTOR, FOR BREAKING THE CHARGING AND DISCHARGING CIRCUITS.

On again reducing the P.D. limit on charging, the P.D. per cell now refusing to rise to 2.35 volts, both the times of charging and discharging became very irregular, and, at length, the time of charging suddenly fell to 10 hours and the time of discharging to six. On carefully examining the plates, they were found to have badly scaled, and to have suddenly become partially short-circuited; they were, therefore, carefully scraped, and the mud allowed to settle at the bottom, where, in consequence of the special construction of the 1888 cell, it could remain without short-circuiting the plates. Only a few plugs fell out in this operation. This sediment was afterwards weighed and analyzed, showing a composition that will be referred to in Section VIII., on the Chemical Action.

We now concluded that we had been running the cells too low, and we, therefore, decided to stop the discharge when the P.D. per cell fell to 1.8 volts, retaining the higher limit of 2.4 volts per cell to limit the charge. It is interesting to notice that Dr. Louis Duncan and Mr. H. Wiegand, in their paper on "The Inherent Defects of Lead Batteries," read before the American Institute of Electrical Engineers, and which we saw for the first time at the end of June, 1889, reprinted in *The Electrical World*, come to exactly the same conclusion—that the discharge should be terminated at 1.8 volts per cell, otherwise there is a formation of white lead sulphate and a rapid depreciation of the cell. From what we have since seen, we think that the discharge should be stopped even still sooner—when the P.D. per cell has reached 1.9, or 1.85 volts at the lowest.

We, therefore, adjusted the automatic interruptor to stop the discharge when the P.D. per cell was 1.8 volts, and the immediate result of this was to bring the time of charging up to 12½ hours, and to bring up the time of discharging to 10½ hours. After continuing the charging and discharging continuously day and night for 13 days, the cells reached a perfectly steady state. Fig. 8 shows the time curve of P.D. per cell in the discharges finished in the early morning of June 19th, recommenced in the night of June 19th, and again commenced late on June 20th, all the three discharges being so precisely similar that they can be represented by one curve; and, similarly, Fig. 9 shows the intermediate charging curves on June 18th, 19th and 20th, which were also exactly the same. The times of the three discharges and of the three charges were, respectively, in hours and minutes

TIMES OF SUCCESSIVE.

Discharges.	Charges.
10 h. 10 m.	11 h. 38 m.
10 h. 10 m.	11 h. 37 m.
10 h. 11 m.	11 h. 37 m.

showing to what an absolutely definite state cells arrive after a definite cycle of charge and discharge between fixed limits has been repeated continuously, without interruption, for some weeks.

Integrating these curves, we find

Discharge.		Charge.		Percentage Working Efficiency.	
Amp. Hours.	Watt Hours per cell	Amp. Hours.	Watt Hours per cell	Quan.	Energy.
101.9	201.7	104.5	230.7	97.2	87.4

The numbers contained in this last table may probably be considered as giving the steady working values for this size and type of cell. 230.7 watt hours are equivalent to 612,200 foot-lbs., and as the positive and negative plates of one cell weigh 28 lbs. 10 oz., the working storage capacity is 21,380 foot-lbs. per lb. of plate.

VII.—EFFECT OF REST,

We next tried the effect produced on the capacity and efficiency of accumulators by prolonged rests. The five cells used in the experiments stood on porcelain insulators containing resin oil; and as the insulators, which were specially made for the central institution, were taller than those commonly employed to support accumulators, and as all connecting wires were removed from the cells while they were allowed to rest, it is certain that any change in the cells must have been caused by internal action, and could not have been due to external leakage.

The cells, having been fully charged on June 22d, were allowed to rest, insulated as above described, until July 2d—that is, for 10 days. The first few curves of discharge and charge after the rest showed a considerable diminution in the capacity and efficiency; but after one week's continuous charging day and night a steady cycle was reached, the following being the times of successive discharges and charges, the limiting P.D.'s, as before, being 1.8 and 2.4 volts:

TIMES OF SUCCESSIVE

Discharges.	Charges.
10 h, 1 m.	11 h. 35 m.
9 h. 59 m.	11 h. 30 m.
9 h. 58 m.	11 h. 32 m.
9 h. 57 m.	11 h. 33 m.

Curves 10 and 11 show the variation of the P.D. per cell, and on integrating these curves we obtain—

Discharge.		Charge.		Percentage Working Efficiency.	
Amp. Hours.	Watt Hours per Cell.	Amp. Hours.	Watt Hours per Cell.	Quan.	Energy
100	198	103.8	228.2	96.4	85.8

Rest, then, of an accumulator, although left well insulated and fully charged at the commencement, alters the accumulator so that for the first few charges and discharges after the rest it is a much less valuable instrument than before. A week's continuous charging and discharging day and night, however, removes this effect to a great extent; the efficiency, however, still remains somewhat lower than before the rest.

Next, the cells were allowed to rest charged for 12 days, until August 1st. The first discharge at the end of the rest gave a quantity efficiency of only 80 per cent., so that 20 per cent. of the charge was lost. After a week's continued charging and discharging between the former limits of volts, the cells regained a steady state, but the time of charge and of discharge is now less than before this second rest. The times after the week's charging and discharging were

TIMES OF SUCCESSIVE

Discharges.	Charges.
9 h. 3 m.	10 h. 41 m.
9 h. 2 m.	10 h. 44 m.
9 h. 10 m.	10 h. 51 m.

Curves 12 and 13 show the P.D. curves when the cells had acquired a steady state, and on integrating them we find

Discharge.		Charge.		Percentage Working Efficiency.	
Amp. Hours.	Watt Hours per cell	Amp. Hours.	Watt Hours per cell	Quant.	Energy
91	176.7	96.8	213.2	94.1	82.8

We see, then, that a week's continuous charging and discharging of these cells is unable to compensate for the harm produced by their being left for 12 days fully charged. The two rests of 10 days and 12 days, respectively, although followed in each case by a week's continuous charging and discharging, have reduced the discharge ampere hours by 10 per cent., the discharge watt hours by 12 per cent., the quantity efficiency by 3 per cent., and the energy efficiency by 5 per cent.

Third Rest.—The cells having been fully charged, a third rest of 16 days took place. On the first discharge, at the normal rate of 10 amperes, the ampere hours were only 75. After, however, the charging and discharging at the normal rates had been continued for three days and nights, the times of discharging and charging became steady.

TIMES OF SUCCESSIVE.

Discharges.	Charges.
8 h. 12 m.	9 h. 28 m.
8 h. 17 m.	9 h. 35 m.
8 h. 19 m.	9 h. 35 m.

and Curves 14 and 15 show the working values of the P. D. in discharging and charging. Integrating the curves, we obtain:

Discharge.		Charge.		Percentage Working Efficiency.	
Amp Hours.	Watt Hours per cell	Amp Hours.	Watt Hours per cell	Quan.	Energy.
82.6	161.3	86.2	190.5	95.8	84.7

Fourth Rest.—The cells, having been fully charged, were allowed to rest for 16 days. Curve 16 gives the values of P. D. obtained at the *first discharge*, and Curve 17 the values of the P. D. obtained immediately afterward in charging. Integrating the former curve, and comparing its area with the area of the charge curve (15) obtained just before the rest, we find:

First Discharge after Rest.		Last Discharge before Rest.		Percentage Efficiency.	
Amp. Hours.	Watt Hrs. per Cell.	Amp. Hours.	Watt Hrs. per Cell.	Quan.	Energy
56.5	110.5	86.2	190.5	65.5	58

If, however, we compare the result of the first discharge after the rest with the first subsequent charge, shown in Curve 17, we find:

First Discharge after Rest.		First Charge after Rest.		Percentage Efficiency.	
Amp. Hours.	Watt Hrs. per Cell.	Amp. Hours.	Watt Hrs. per Cell.	Quan.	Energy
56.5	110.5	71.1	158.3	79.6	69.6

The cells were now continuously, without intermission, charged with the normal current of nine amperes and discharged with 10; the discharge, as before, being automatically stopped when the P. D. per cell had fallen to 1.8 volts, and the charge when it had risen to 2.4 volts. The following give the successive times in hours and minutes in which the cycles were completed:

First discharge after rest, 5 h. 40 m.
First charge, 7 h. 54 m.
Second discharge after rest, 7 h. 6 m.
Second charge, 8 h. 30 m.
Third discharge after rest, 7 h. 31 m.
Third charge, 8 h. 51 m.
Fourth discharge after rest, 7 h. 29 m.
Fourth charge, 8 h. 52 m.
Fifth discharge after rest, 7 h. 43 m.
Fifth charge, 9 h. 17 m.

* As it was undesirable to risk an expensive watch, we purchased one of the watches that could be then obtained in St. Paul's Churchyard for three shillings and five pence halfpenny. This watch was very substantial, had a very strong hairspring, which could not be easily damaged, and was an excellent timekeeper—far superior to many watches of a far more expensive character.

† See paper on "Galvanometers," *Phil. Mag.*, July, 1890.

Sixth discharge after rest, 8 h. 0 m.
Sixth charge, 9 h. 24 m.
Seventh discharge after rest, 8 h. 5 m.
Seventh charge, 9 h. 17 m.
Eighth discharge after rest, 7 h. 57 m.
Eighth charge, 9 h. 20 m.

From the last three discharges and charges we see that the cells have arrived at a steady state, and Curves 18 and 19 show the steady, or working, values of the P. D. for these three discharges and charges. Integrating the areas of these two sets of curves, we find

Discharge.		Charge.		Percentage Working Efficiency.	
Amp. Hours.	Watt Hours per cell	Amp. Hours.	Watt Hours per cell	Quan.	Energy
80	156.9	83.8	184.6	95.5	85

Fifth Rest.—The cells were now left charged for a further period of 16 days. Curve 20 gives the values of the P.D. obtained at the first discharge after the rest, and Curve 21 the values of the P.D. obtained immediately afterwards in charging. Integrating the areas of these curves, we have

First Discharge After Rest.		Last Discharge Before Rest.		Percentage Efficiency.	
Amp. Hours.	Watt Hours per cell.	Amp. Hours.	Watt Hours per cell	Quan.	Energy
53.3	104.1	83.8 First Charge After Rest.	184.6	63.6	56.4
		58.5	128.3	91.1	81.1

Continuous charging and discharging, with the normal currents between the normal limits of P. D. per cell, gave the following times for completing the cycles:

First discharge after rest, 5 h. 20 m.
First charge, 6 h. 30 m.
Second discharge after rest, 6 h. 18 m.
Second charge, 7 h. 29 m.
Third discharge after rest, 6 h. 42 m.
Third charge, 7 h. 59 m.
Fourth discharge after rest, 6 h. 54 m.
Fourth charge, 8 h. 19 m.
Fifth discharge after rest, 7 h. 15 m.
Fifth charge, 8 h. 20 m.
Sixth discharge after rest, 7 h. 16 m.
Sixth charge, 8 h. 30 m.
Seventh discharge after rest, 7 h. 23 m.
Seventh charge, 8 h. 41 m.
Eighth discharge after rest, 7 h. 34 m.
Eighth charge, 8 h. 44 m.
Ninth discharge after rest, 7 h. 40 m.
Ninth charge, 8 h. 47 m.

It was concluded from the times of the last three charges and discharges that the cells had acquired a steady state, and Curves 22 and 23 show the time fall and the time rise of P.D. Integrating the areas of these curves, we have:

Discharge.		Charge.		Percentage Working Efficiency.	
Amp. Hours.	Watt Hours per cell	Amp. Hours.	Watt Hours per cell	Quant.	Energy
76	149.5	78.3	173.2	97.1	86.3

The following table gives a *resumé* of these results, all the discharges being made with 10 amperes until the P.D. fell to 1.8 volts per cell, and all the charges being made with 9 amperes until the P.D. per cell rose to 2.4 volts. Before each rest the cells were charged until the P.D. per cell was 2.4 volts.

From the preceding table it will be seen that, in spite of the continued charging and discharging at the end of each rest, there is a steady falling off in the quantity capacity from 101.9 ampere hours at the beginning to 76 ampere hours at the end, and in the energy capacity from 201.7 watt hours to 149.5 watt hours. The quantity and energy efficiencies, 97.1 and 86.3 per cent. respectively, at the end are the same as at the beginning. Comparing the first discharge after each of the 16 days' rest with the last charge before the rest, there appears to be a loss of about 36 per cent. in the ampere hours, and about 43 per cent. in the watt hours; or, since the normal quantity and energy efficiencies for a discharge immediately following a charge are, respectively, 97 and 87 per cent., it follows that the rest of 16 days causes a loss of about 33 per cent. in the ampere hours, and about 30 per cent. in the watt hours, in addition to the losses that normally occur on a charging immediately followed by a discharging.

From all that precedes, it follows that the previous history of an accumulator produces an enormous effect on its efficiency. If, for example, an E.P.S. accumulator be over and over again carried round the cycle of being charged up to 2.4 volts per cell and discharged down to 1.8 volts per cell, the charging and discharging currents being the maximum allowed by the makers—viz., 0.026 ampere per square inch in charging, and 0.029 ampere per square inch in discharging—the "*working efficiency*" thus obtained may be 97 per cent. for the ampere hours and 87 per cent. for the watt hours. If, on the contrary, the cell be constantly charged up before being tested, then for the first few charges and discharges between the above limits, and with the same current density in charging and discharging, even the *energy* efficiency may be as high as 93 per cent.; whereas, if the accumulator has been left for some weeks, then, although it was left charged, the energy efficiency for the first few charges and discharges will be as low as 70 per cent.

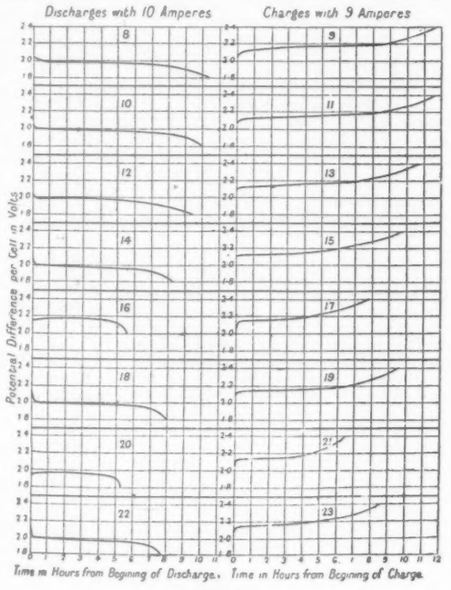

Discharges with 10 Amperes
Charges with 9 Amperes
Potential Difference per Cell in Volts
Time in Hours from Beginning of Discharge.
Time in Hours from Beginning of Charge.

FIG. 8.

While, on the one hand, our tests show that continued rests of a charged accumulator appear to be far more serious for the accumulator than we had previously imagined, the working efficiency appears to be higher than has hitherto been supposed, since we believe that about 84 per cent. efficiency in the watt hours is all that the advocates of accumulators have claimed for them.

The smallness of the first discharge after a rest might be due, either to a kind of electric short-circuiting and dissipation of the energy, or to some change in the character of the active material converting the energy perhaps directly into heat, or to some of the active material having become disconnected from the plates during the rest and having fallen down to the bottom of the cell. The smallness of the first *charge* subsequently to the first discharge after the rest, shows that mere electrical leakage during that time has not been the cause of the loss of energy, while the steady increase in the storage capacity brought about by a series of charges and discharges tends to show that rest brings about some change in the nature of the active material.

In all the tests in which the results are given in the preceding table, the charge and discharge were, as already stated, terminated when the P. D. per cell reached a fixed value; it is, therefore, possible that the apparent falling off in the capacity of the cells to store energy may be due to a change in the resistance of the cells produced by the rest. For a change in the resistance of the cells will change the terminal P. D. for a given current flowing through the cells without there being any necessary change in the storage capacity.

It is, therefore, interesting to study the variations in the shapes of the P. D. Curves 8 to 23. First, as regards the charge curves, 9 and 11 are convex everywhere to the axis of time except just when the charging is commenced; whereas 13, the steady working charge curve after the second rest, rises much more rapidly when the P. D. cell is about 2.3 volts than is the case in the other two curves, then bends over and becomes concave to the axis of time. This peculiarity in Curve 13 is, we notice, not very striking in the small reproduction of this curve in the text, but in the original curves, as plotted on large sheets of squared paper from the results of the tests, the difference between Curves 11 and 13 is very noticeable.

The following list gives the time in hours and minutes from the commencement of the charging when the P.D. per cell reaches 2.2 volts.

Curve 9..7 h. 14 m..Steady working charge before rests.
" 11..7 h. 32 m..Steady working charge after first rest.
" 13..7 h. 10 m..Steady working charge after second rest.
" 15..5 h. 36 m..Steady working charge after third rest.
" 17..3 h. 54 m..First charge after fourth rest.
" 19..5 h. 43 m..Steady working charge after fourth rest.
" 21..4 h. 50 m..First charge after fifth rest.
" 23..4 h. 40 m..Steady working charge after fifth rest.

It is clear, then, that the effects of a series of rests is to cause the P.D. to rise much more rapidly in subsequent charges, and the time curve rise of P.D. still remains unusually steep, although at the end of every rest there was a prolonged and uninterrupted series of charges and discharges.

Curves 16 and 20, which give the values of the P.D. for the *first* discharges after the fourth and fifth rests, show that for the first hour from the beginning of each of these discharges the P.D. *rises instead of falling*, as is the case in normal discharges.

If the rapid fall of P.D. at the commencement of a discharge be due to a disappearance of gases occluded in the plates, as some have supposed—or, if, as Dr. Gladstone and Mr. W. Hibbert imagine, the charging of a cell causes the acid round the positive plate to become denser than that round the negative, and the mixing of the denser and less dense acid at the commencement of the discharge causes the P.D. to fall—then the absence of this fall at the beginning of a discharge after a long rest would be explained; but neither of these theories would apparently explain the rise of the P.D. obtained by us at the commencement of a discharge after a long rest. Indeed, the fact that it required two discharges and two charges after a long rest before the discharge curve (the third after the rest) acquired its normal form, tends to show that this rise of P.D. at the commencement of the first discharge after a long rest is due to some other cause.

Again, Prof. Duncan and Mr H. Wiegand have shown in their communication that the diffusivity of the sulphuric acid into the plugs is greatest at the end of the charge, and least at the end of the discharge. Hence, if it be the diffusing out of the strong sulphuric acid from the plugs of the positive plate that causes the rapid fall of E.M.F. on breaking the charging circuit at the end of a charge (see Figs. 3, 4, and 11), one would hardly expect that it would be at the *end* of the discharge, when the diffusivity of acid in the plugs was a minimum, that the rise of E.M.F. on breaking the discharging circuit would be most rapid, but that numerous experiments have shown us to be the case. In fact, Curve No. 8, Fig. 11, shows that towards the end of the charge the E.M.F. falls from 2.298 to 2.274 volts in 20 seconds after breaking the charging circuit, and similar curves that we have drawn from our experiments on the time rise of E.M.F. on breaking the discharging circuit show that towards the end of the discharge the E.M.F. rises from 1.951 to 1.970 volts in 20 seconds, the latter rate of rise being almost exactly equal to the former rate of fall.

All the rests already referred to occurred when the cells were fully charged; but before these long rests took place the cells when in their normal state were on one occasion allowed to remain discharged for 34 minutes, with the following result:

CELLS IN NORMAL STATE.

Time taken to complete
Charging, 11 h. 38 m.
Discharging, 10 h. 10 m.
Next charging, 11 h. 37 m.
Next discharging, 10 h. 12 m.
Next charging, 11 h. 37 m.
Next discharging, 10 h. 11 m.
Cells here remained discharged for 34 m.
First charging after rest, 11 h. 50 m.
First discharging after rest, 10 h. 15 m.
Next charging after rest, 11 h. 42 m.

These results emphasize the fact that accumulators are damaged if left discharged even for a short time, and it was for this reason that during the whole of this investigation the cells were never left discharged for a longer time than was necessary to change over the connections from discharge to charge, except on this one occasion, when it was desired to ascertain the magnitude of the change produced by leaving the cells discharged for a short time.

It is interesting to notice that the effect of discharging cells too low, or of leaving them discharged, is to increase the times required for the subsequent chargings, whereas the effect of leaving them charged is to diminish the times required for the next chargings.

(To be concluded next week.)

Discharge.				Charge.				Percentage Efficiency.	
Duration of Discharge	Ampere Hours.	Watt Hours per Cell	Number of Curve.	Duration of Charge	Ampere Hours.	Watt Hours per Cell	Number of Curve.	Quantity.	Energy.
				Cells in Normal State.					
h. m. 10 12	101.9	201.7	8	h. m. 11 38	104.5	230.7	9	97.2	87.4
	Rest of 10 days. Cells then charged and discharged many times until brought to a steady working state.								
10 0	100	196	10	11 31	103.8	228.2	11	96.4	85.8
	Rest of 12 days. Cells then charged and discharged many times until brought to a steady working state.								
9 8	91	176.7	12	10 45	96.8	213.2	13	94.1	82.8
	Rest of 16 days. Cells then charged and discharged several times until brought to a steady working state.								
8 24	82.6	161.3	14	9 36	86.2	190.5	15	95.8	84.7
	Rest of 16 days. *First* discharge and charge after rest.							Ratio of first discharge *after* rest to last charge *before* rest. 65.4	58.0
5 41	56.5	110.5	16	7 54	71.1	158.3	17	Ratio of first discharge *after* rest to first charge *after* rest. 79.6	69.6
	Cells now charged and discharged several times until brought to a steady working state.								
8 0	80	156.9	18	9 20	83.8	184.6	19	95.5	85.0
	Rest of 16 days. *First* discharge and charge after rest.							Ratio of first discharge *after* rest to last discharge *before* rest. 68.6	56.4
5 21	53.3	104.1	20	6 30	58.5	128.3	21	Ratio of first discharge *after* rest to first charge *after* rest. 91.1	81.1
	Cells now charged and discharged several times until brought to a steady working state.								
7 16	76	149.5	22	8 32	78.3	173.5	23	97.1	86.3

The Indianapolis Electric Railway.

Secretary Anderson, of the Indianapolis, Ind., Citizens' Street Railway Company, furnished a local newspaper man with the following statement:

"We have 990 mules and 46 horses; 90 open and 105 closed cars, with 16 new open cars ordered. At present we are employing about 625 men in all, owing to improvements that are being put in, and regularly employed about 550 men. We pay car drivers 14 cents an hour, motor men 15 cents and conductors 16 cents; the men work on an average 12 hours a day. The stable men get 11 cents an hour and track men from $1.25 to $1.40 a day. We are now operating about 60 miles of track. We are very well pleased with our electric line, and think there can be no doubt but that in a few years electricity will be used all over the city. The company has now two dynamos of 80 horse-power each, and have ordered another and when it is received there will be run two trailers with each motor car. Our boiler is 500 horse-power, and the engine 250, consequently, we can put in another engine of 250 horse-power.

"The Street Car Employés' Benefit Association was organized in 1887, and we now have a membership of over 250, and have paid in benefit and doctor bills on an average of $1,300 a year. Our employés are all a good class of men, as will be seen by the fact that in two building associations alone, they pay in weekly nearly $300."

KINDRED INTERESTS

The Universal Radial Drill Company, Cincinnati, are out with a handsome calendar for August. The front contains a cut of one of their drills, and the reverse side has a cut of their factory.

The Western Electric Company has just placed a 500-light dynamo, and the Atlas Engine Company a 70-horse power engine to drive it, in the new Exchange building at the stock yards, in Minneapolis, Minn.

The Pond Engineering Company, of St. Louis, have opened branch offices at Dallas, Tex., and Seattle, Wash. These additions to their already numerous branches were made necessary by their rapidly increasing business.

The Armington & Sims Engine Company, of Providence, report that business has never been more prosperous with them than at the present time. Large foreign orders in addition to those from domestic customers are constantly received.

The River and Rail Electric Company, 45 Broadway, have a neatly fitted up room, where their various apparatus is shown to good advantage. The exhibition includes storage batteries, motors, physicians' head-lamps, carriage lights and other interesting electrical appliances.

The "C. & C." Electric Motor Company, 402 and 404 Greenwich street, New York, now have over 10,000 motors in actual operation. The output during the past six weeks has been extremely large; in fact, the sales during this short period have amounted to more than the deliveries in any entire year.

The Seely & Taylor Manufacturing Company, 24 Cortlandt street and 19 Dey street, have recently gotten up a new insulating, fireproof and waterproof paint called "Sealine." It is perfectly flexible when dry, and seems to possess just the requisite qualities which make such a paint invaluable to the practical electrician.

The Scott Electrical Works, 26 Liberty street, have recently fitted out the steamer "Connecticut" with one of their powerful Huntington search-lights. They have also equipped the same vessel with a novel electrical whistle-blowing device for use in fogs. By simply throwing a switch, the apparatus is set in motion, blowing the whistle every ten seconds. The search-light is placed on top of the pilot house, and is operated by a system of levers from within the house.

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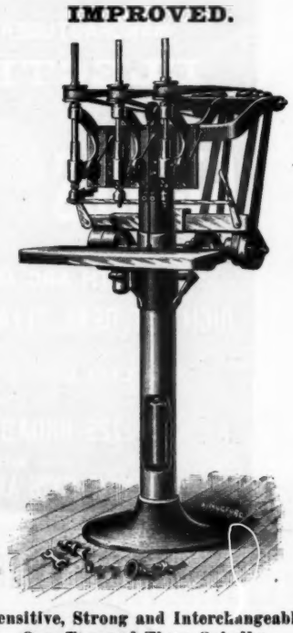

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ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON JULY 29, 1890.

432,965 Electric light fixture; Fred. H. Aldrich, Cadillac, Mich.
432,973 Galvanic battery; Horatio J. Brewer, New York, N. Y.
432,978 432,979 Electric cut-out. 432,980 Fuse block and lightning arrester; Henry A. Chase, Boston, Mass.
432,988 Automatic electric switch and cut-off; Chas. B. Doyle, Maywood, Ill.
433,022 Electro-magnetic cut-out; Bernice J. Noyes, Boston, Mass.
433,025 Conduit for telegraph cables; William R. Patterson, Chicago, Ill., assignor to the Western Electric Co., same place.
433,041 Electrode for arc lamps; Llewellyn Saunderson, Kingstown, County of Dublin, Ireland.
433,045 Safety cut-out. 433,047 Test circuit for multiple switchboards. 433,424 Combination telephone key; Chas. E. Scribner, Chicago, Ill., assignor to the Western Electric Co., same place.
433,051 Dynamo electric machine; Henry W. Spang, New York, N. Y.
433,082 Dynamo Telegraphy; Francis W. Jones, New York, N. Y.
433,120 Telephone; Stephen D. Field, Yonkers, N. Y.
433,170 Electric railway; Rudolph M. Hunter, Philadelphia, Pa., assignor to the Electric Car Co. of America, same place.
433,174 Separator for secondary batteries; Wm. P. Kookogey, Brooklyn, N. Y., assignor to the Kookogey Electric Co.
433,180 Electro-motor traction wheel. 433,181 System of electrical transportation; Albert L. Parcelle, Boston, Mass., assignor to the Florence Motor Co., of Maine.
433,210 Electric apparatus for railways; John B. Odell, Chicago, Ill.
433,216 Automatic electric train signal; Albert W. Reppy, Oakland, Cal., assignor of one-half to Thaddeus C. Mastelier, same place.
433,217 Thermal cut-out; Alexander Bernstein, London, County of Middlesex, England, assignor by mesne assignments, to the Bernstein Electric Co., Boston, Mass.
433,266 Pole for supporting electric wires; Leonard Atwood, Philadelphia, Pa.
433,269 Regulator for dynamo electric machines; Perley P. Belt, Fredonia, Kan.
433,307 Telephone call register; Willis E. Robinson, Fairbault, Minn.
433,359 Rheostat switch 433,360 Electric switch; James F. McLaughlin, Philadelphia, Pa.
433,371 Holder for incandescent electric lamps; Adolf Schriner, Berlin, Germany.
433,375 Electric heat regulating system; Frank M. Sparrow, Mattapoisett, Mass.
433,381 Electro-magnetic transmitter; John T. Williams, Mt. Vernon, N. Y., assignor to the International Port Electric Co., New York, N. Y.
433,384 Electrical syringe; James H. Woodward, Seward, Neb.
433,390 Brush holder for electrical machines. 433,391 Armature for dynamos, etc. 433,392 Blank for armature coil guards. 433,393 Commutator for dynamos. 433,394 Power transmitting mechanism; Warren S. Belding, Englewood, Ill.
433,400 Magnetic coupling device. 433,401 Variable speed gearing for electric cars. 433,402 Reversing gear for electric cars; Theodore M. Foote, Boston, Mass.
433,407 433,408 Electric railway; Rudolph M. Hunter, Philadelphia, Pa., assignor to the Thomson-Houston Electric Co., of Connecticut.
433,409 Electric railway; Herbert B. Keithley, Denver, Col.
433,421 Telegraphic circuit; Arthur C. Robbins, Brooklyn, assignor to William S. Andrews, New York, N. Y.
433,435 Contact device for electric railways; Frank J. Sprague, New York, N. Y., assignor to the Sprague Electric Railway and Motor Co., same place.
433,480 Lightning arrester; Alexander Wints and Oscar H. Baldwin, Pittsburgh, Pa., assignor to the Westinghouse Electric Co., same place.

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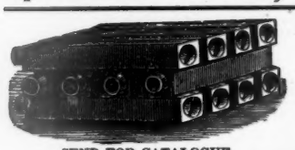
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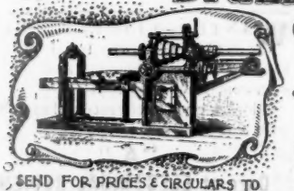
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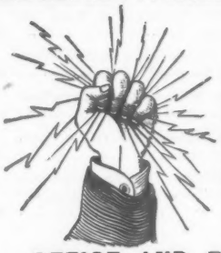
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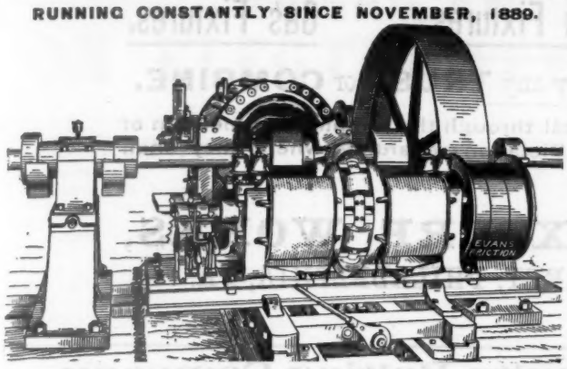

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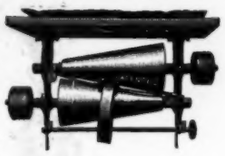

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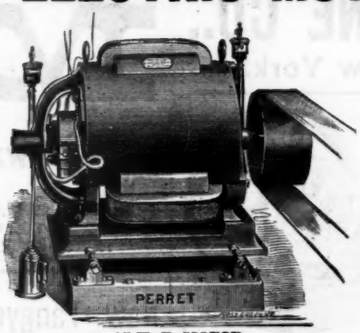

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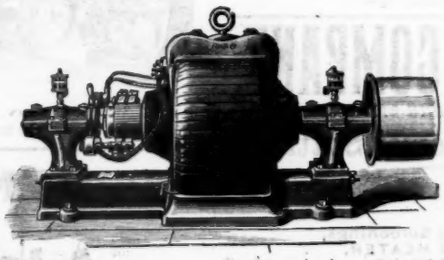

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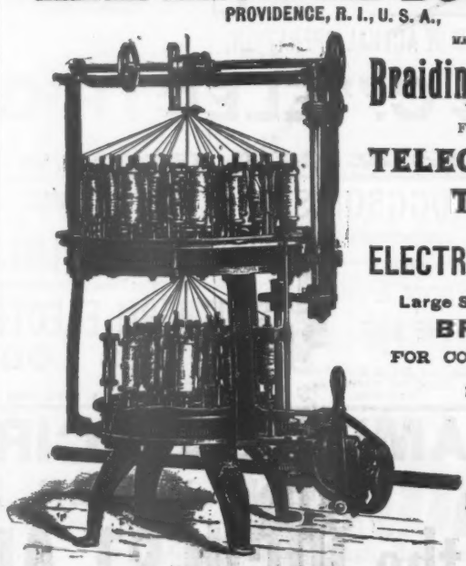

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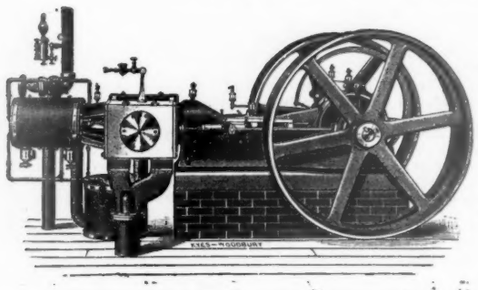

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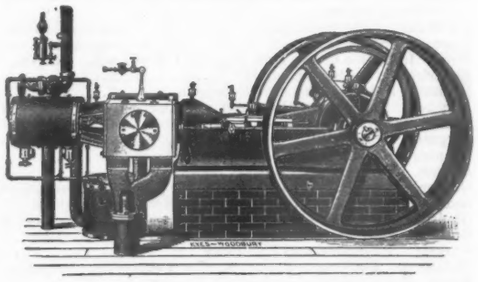

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C	8	.....	.....	.....	6.5	1½	5,000 FEET PER MINUTE.	530
C	.....	10	.....	.....	6.3	1½		530
C	.....	.....	.....	25	8.0	2		530
E	16	.....	.....	.....	12.0	2½		780
E	.....	20	.....	.....	12.5	2½		780
E	.....	.....	26	.....	13.0	2½		780
F	30	.....	.....	.....	15.0	3		990
F	.....	25	.....	.....	15.6	3		990
F	.....	.....	32	.....	15.0	3		990
F	.....	.....	.....	50	16.0	3		990
G	28	.....	.....	.....	21.0	4½		1,360

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G	.....	35	.....	.....	21.0	4	5,000 FEET PER MINUTE.	1,360
G	.....	.....	45	.....	21.0	4		1,360
G	.....	.....	.....	70	21.0	4½		1,360
H	40	.....	.....	.....	29.7	6		1,750
H	.....	50	.....	.....	30.0	6		1,750
I	.....	.....	64	.....	29.5	6		1,750
I	52	.....	.....	.....	38.0	8		2,290
I	.....	65	.....	.....	38.6	8		2,290
J	.....	.....	83	.....	38.0	8		2,290
J	64	.....	.....	.....	46.5	10		2,770
J	.....	80	.....	.....	47.1	10		2,770
K	75	.....	.....	.....	52.5	12		3,300

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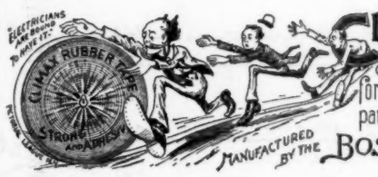

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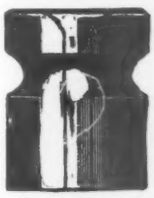

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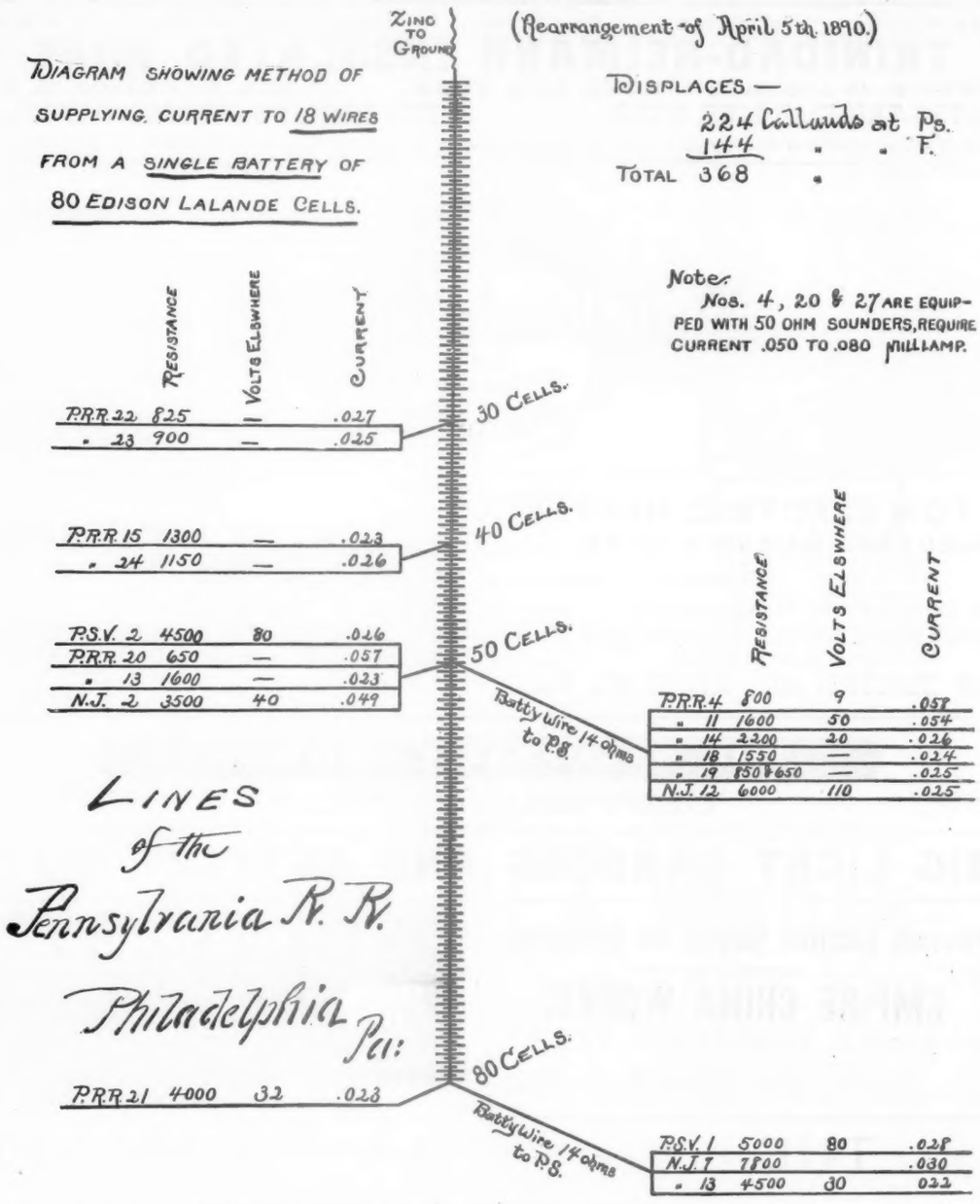
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(Rearrangement of April 5th 1890.)
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" 23 900 — .025
40 Cells.
P.R.R. 15 1300 — .023
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" 13 4500 30 022

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Sir WILLIAM THOMSON, F. R. S., and Dr. JOHN HOPKINSON, F. R. S.,

Versus

Mr. BOTTOMLEY and Mr. HARBER.

ENGLISH EXPERTS' OPINIONS.

Sir WILLIAM THOMSON, F. R. S.

THE UNIVERSITY, GLASGOW, June 19th, 1890.

I have tested the insulation of two specimens of Okonite Wire sent to me recently, and have found thoroughly satisfactory results for all ordinary temperatures and potentials.

The thickness of the Okonite in these specimens was 1.8 millimeters (.072 of an inch), and its insulation held good up to 7,500 volts. After the passing of current through it at this very high potential for some time, I found the insulation resistance for ordinary potentials only reduced from 6,700 (its original value) to 4,500 megohms per statute mile at 16° Cent.

I am well acquainted with Dr. Hopkinson's tests of December, 1886, which were submitted to me early in 1887, and I know the results of his recent tests of the same specimens, showing no deterioration, but actually an improvement in the insulating quality after three and a half years' keeping.

I have also seen the published certificates of many practical men of different dates from March, 1886, to December, 1888, which give trustworthy evidence of the practical success of Okonite Wire for telegraphs, telephones and electric light and power.

With this evidence before me, in addition to my own electric tests and examination of the insulating material in respect to toughness and other mechanical qualities, I believe Okonite to be a very valuable material for the insulation of electric conductors in a large variety of practical uses.

(Signed) WILLIAM THOMSON.

Dr. JOHN HOPKINSON, F. R. S.

WESTMINSTER CHAMBERS, 5 VICTORIA STREET, S. W., June 19th, 1890.

In December, 1886, I made a series of careful and somewhat elaborate experiments upon Okonite Wire, and fully reported upon the same. My report, of which I append a copy, was as complete as it could be at the time. One point it was then impossible to determine, and that, practically, the most important point of all, namely, the question of the durability of the insulation.

It is almost impossible, in most instances, to judge of the suitability of any particular insulating compound for wires until it has stood the test of time for some years. It so happened that samples of Okonite Wire that I tested in 1886 had been left with me and have remained in my possession ever since, parts of the same having been used in my laboratory and for various other purposes.

I have now again tested these samples, and append the tests, together with the results obtained in 1886. In the case of A and C, the test is after one minute's electrification; in the case of B_1 and B_2, the test is a mean during an interval from one-half minute to five and one-half minutes from first electrification; the temperatures are practically the same, viz., 15°5C. in 1886, 15°C. now. Samples A and C had been immersed in water for five days, B_1 and B_2 for a shorter time. B_1 is a sample which had been twisted in 1886 for the purpose of ascertaining whether the material would stand mechanical disturbance. B_2 had six kinks made in it for a similar purpose.

A, in 1886	....	....	6,180	A, now	...	....	7,000	....	Megohms per statute mile.	
C, in 1886	..	....	7,590	C, now	....	....	11,680	...	do	do do
B_1, in 1886	...	....	5,425	B_1, now	....	....	11,740	....	do	do do
B_2, in 1886	....	....	4,750	B_2, now	....	...	13,700	....	do	do do

In my last report I stated that I was most favorably impressed with the qualities of the wire, both on account of its high insulation and mechanical reliability. Tests on the samples proved that the insulation was practically perfect, both for high and low potentials, and that the insulation would stand very rough handling and a considerable temperature without injury, and, indeed, with but slight reduction of its insulation resistance. I can now add that the result of time has shown that not only is the insulation excellent when made, and that it will stand mechanical disturbance, but that for a term of three and a half years, it is perfectly durable and remains as good as at the first.

(Signed) J. HOPKINSON.

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FIG. 1.

Fig. 1 represents Copper Tee used for branching from main cables, as shown in Fig. 2.

FIG. 2.

Fig. 3 represents a Copper Sleeve used for straight connections for continuation of cables.

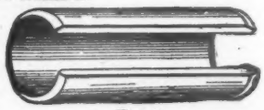

FIG. 3.

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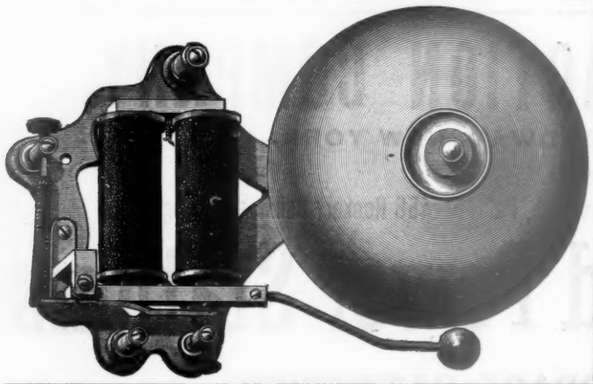

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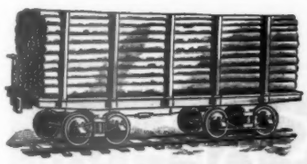

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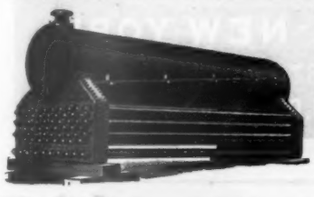

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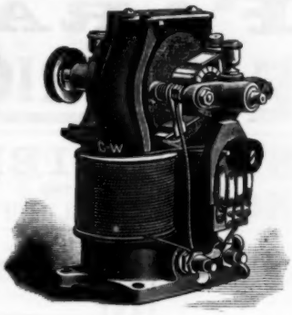

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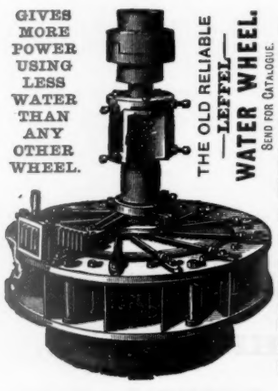

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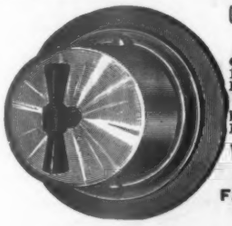

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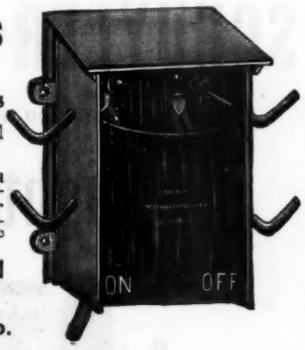

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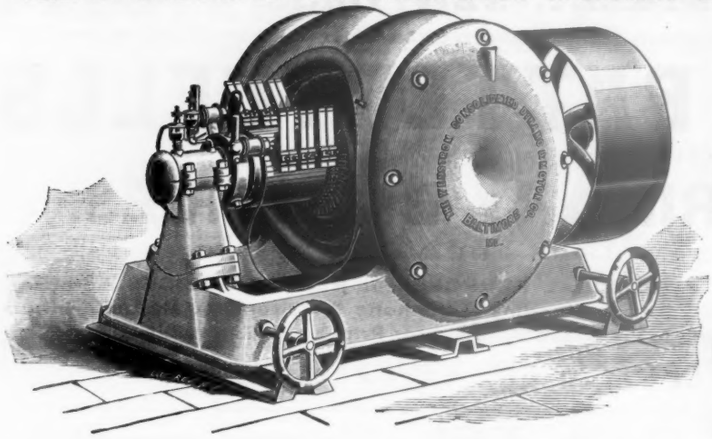

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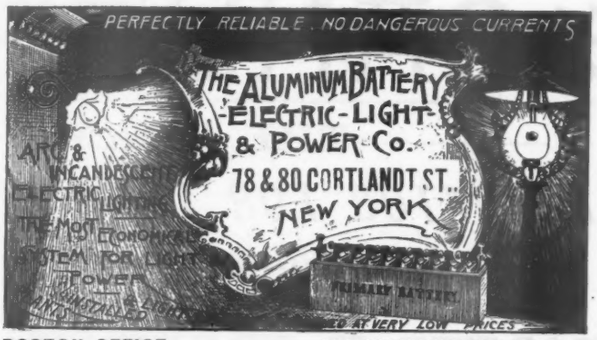

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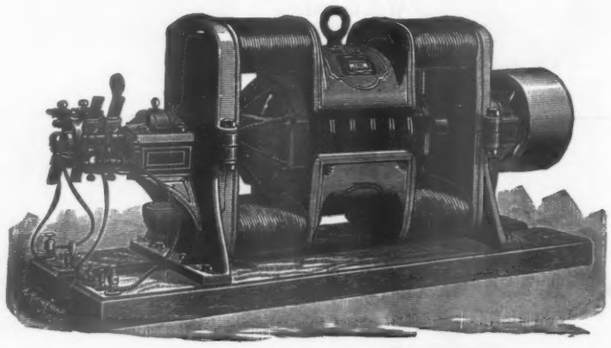

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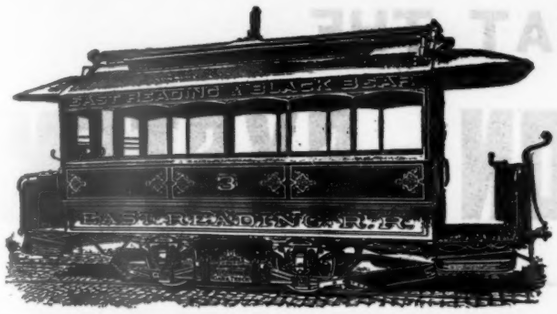

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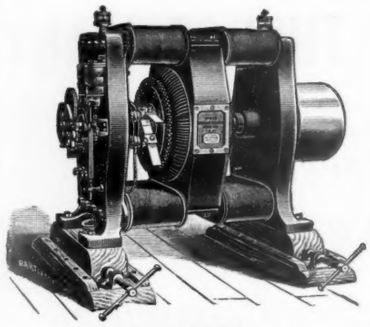

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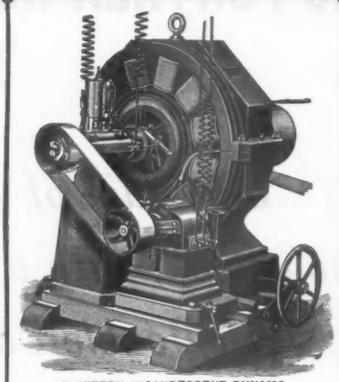

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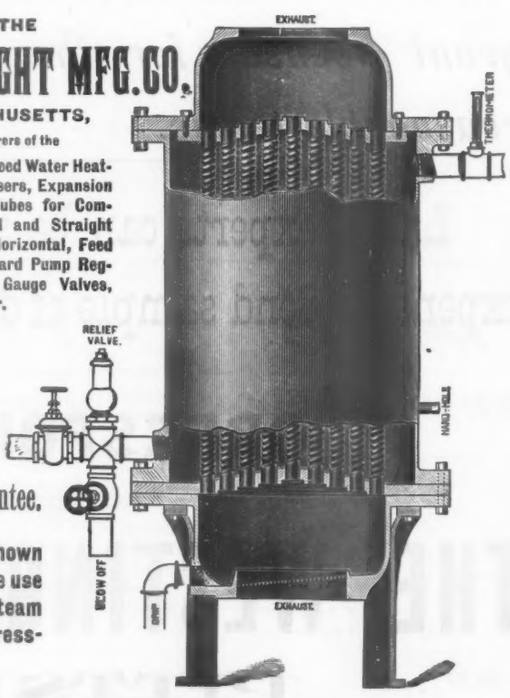

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